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Power Plant of the Electro-Dental Mfg. Co.

COMPACT ISOLATED POWER PLANT FOR LIGHT, POWER AND HEAT. BY WALTER C. EDGE

LOCATED AT 32ND AND Race Streets, Philadelphia, Pa., is the plant of the Electro-Dental Manufacturing Co., well designed to care for the large business of that company in the manufacture of electrical dental instruments.

As shown in Fig. 1, the power house is a separate structure from the main building and, like that, is constructed of reinforced concrete, except one side wall, which is of temporary nature to allow being torn down with little trouble whenever it becomes necessary to enlarge the plant.

All of the equipment consisting of the 2 150-hp. boilers, 2 high-speed engines and all the auxiliaries necessary for the economical operation of the plant, is contained in a structure 30 by 60 ft., yet there is ample room and all apparatus is conveniently located.

BOILER ROOM AND EQUIPMENT

NINE FEET below the surface is the concrete boiler room floor, which can readily be reached direct from the outside, or from the engine room.

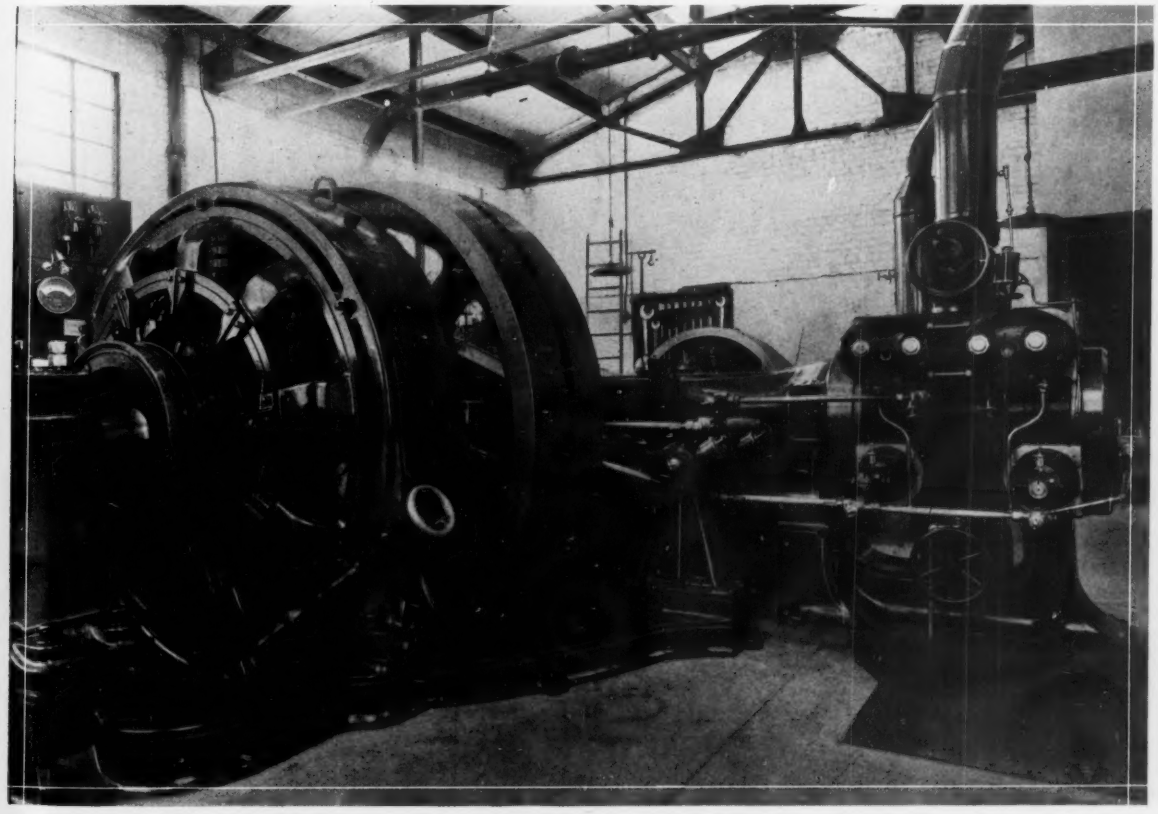


FIG. 4. 100-KW. BURKE-HARRISBURG UNIT

Steam at a pressure of 125 lb. is generated by 2 150-hp. Heine safety water-tube boilers which are equipped with Reliance safety water columns and P. B. H. chain operated gages and gage cocks. Steam pressure is controlled by a Spencer damper regulator and a permanent blower is placed on each boiler for the proper cleaning of the heating surfaces. Schutte and Koerting valves are used for all the heavy boiler connections, while Lunkenheimer globe valves, with renewable discs are used on all other work with the exception of the Chapman gate valves used on the water lines.

Settings are of the Heine standard type and the furnace construction is, in general, exceedingly good, as the writer obtained a reading of 14.6 per cent of CO_2 and no CO when the fires were in good condition and the temperature of the gases leaving the boiler was but

FIG. 1. POWER PLANT OF THE ELECTRO-DENTAL MANUFACTURING CO.

300 deg. F. Coal bins of large capacity are built in front of the boilers, a feature which eliminates the double handling of coal, prevalent in many power plants of this size.

All pumps except the fire and 2 small electrically driven units are located in a separate pump room adjacent to and practically part of the boiler room, where also are the feed-water heater, hot water generator and blowoff tank, as shown in Fig. 2.

The 3 pumps which were above referred to as being placed in the engine room are a 16 by 9 by 12-in. Blake and Knowles fire pump and 2 small motor-driven centrifugal pumps, one of which is utilized to pump out a sump located below the boiler room floor, while the other is used to keep the house tank supplied with the proper amount of water. Both of these centrifugals are automatically controlled.

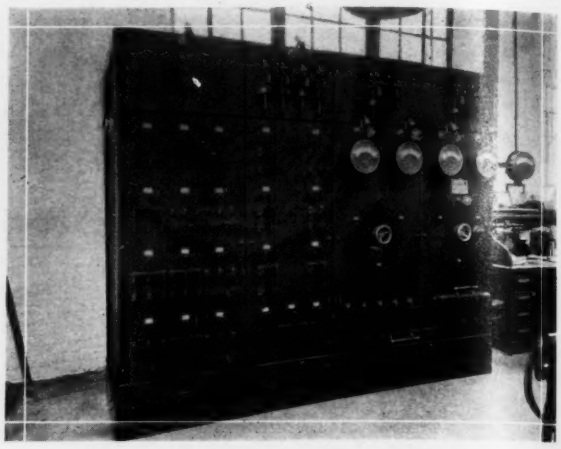


FIG. 5. GENERAL VIEW OF SWITCHBOARD

Two 6 by 4 by 6 McGowan pumps supply the boilers with water from a 450-hp. Cochrane feed-water heater and are cross connected so that they may be used to pump water into the house tank and also to take water

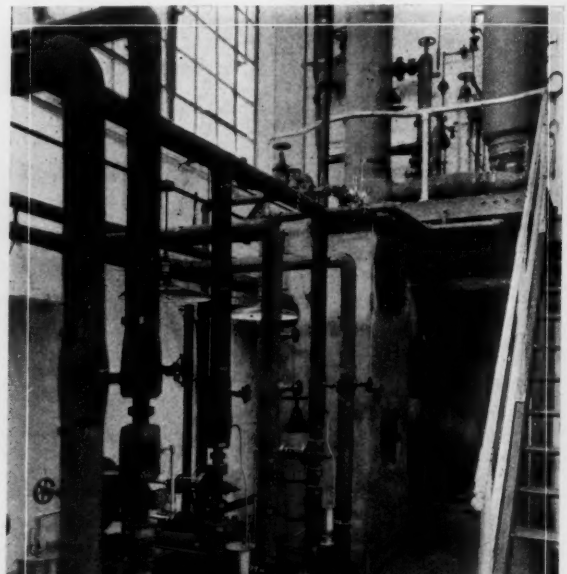


FIG. 2. PUMP ROOM; BOILER FEED PUMPS AND COCHRANE FEED WATER HEATER IN FOREGROUND

direct from the city mains, if necessary. Foster controlling valves and Richardson oil pumps reduce the attention to pumps from the firemen to a minimum. In addition to the above pumps is a 6 by 8 by 12 Burnham

simplex vacuum pump controlled by a Foster vacuum control valve, and, for emergencies, a 2-in. Sellers injector offers a method of boiler feed.

Piping and Auxiliaries

Warren Webster siphon valves are employed to maintain an efficient vacuum system throughout the factory building and in case of a shortage of exhaust steam a 2-in. Foster reducing valve can supply the system with live steam.

A Davis hot water generator supplies all basins with hot water maintained at a temperature of 180 deg. by a Johnson hydraulic thermostat.

Across the top of the boilers at about the center, is a 12-in. header connected to each unit by a 6-in. loop and provided with a blank flange at one end for any additional boilers which may, in the future, be added.

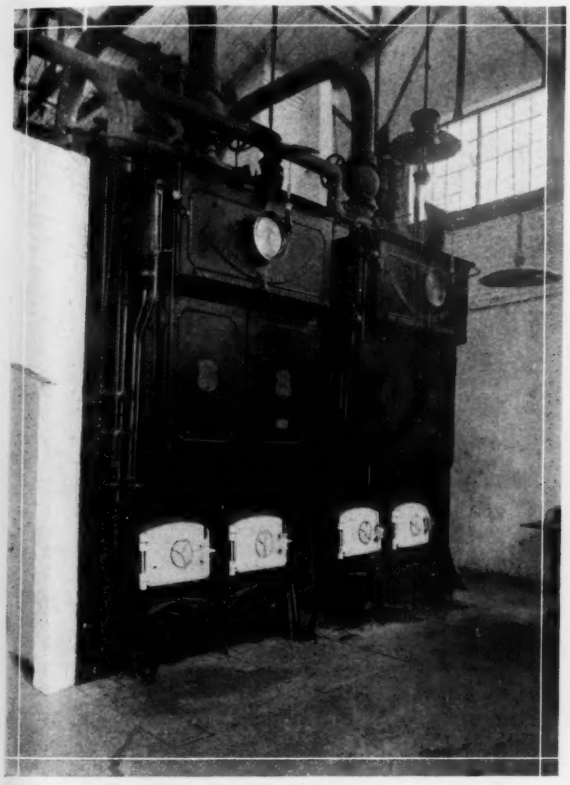


FIG. 3. TWO HEINE BOILERS IN BOILER ROOM

A large receiver-type separator is connected to the header by a 7-in. main branching to the large engine with a 5-in. pipe and to the smaller one with a 3½-in. pipe, while a separate Cochrane vertical separator is used on the small engine. Other lines running from the main boiler header are a 3½-in. to the fire pump and a 3-in. to the other pumps.

For exhaust purposes, a 12-in. main with smaller branches from the various units is employed and connects with the Cochrane heater, the hot water generator and the heating system.

Engine and Generator Equipment

One Harrisburg 10 by 13-in. piston valve engine, direct-connected to a 50-kw., Burke, 3-wire, 110-220-volt generator and one Harrisburg 14½ by 18-in., 4-valve Harrisburg engine, direct-connected to a 100-kw., 3-wire, 110 and 220-volt Burke generator, constitute the generating equipment, part of which is shown in Fig. 4.

The switchboard, measuring 7 ft. 6 in. by 9 ft. is made up, as may be seen in Fig. 5, of 4 panels, 2 generator and 2 distribution, and is provided with the necessary knife switches, circuit breakers, field rheostats, ammeters and a swinging voltmeter.

The 3-wire system is employed throughout the plant, 220-volt service being used for power and 110-volt for lighting, and it has been found possible to carry the load 25 per cent out of balance with a difference of but 3 volts.

Twenty-five motors of various sizes and hundreds of incandescent lamps comprise the connected load, for which all wiring is carried through approved conduits.

This plant was designed by F. M. Yewdell, consulting engineer for Wm. Steel & Sons, of Philadelphia, and is now under the successful operation of J. C. W. Weber, chief engineer.

Plans for the proposed $500,000 experiment station of the United States Bureau of Mines to be located in Pittsburgh, Pa., have been approved by the commission appointed by Congress for that purpose. The Federal Government now owns the property upon which will be erected a group of buildings, especially designed and adapted for the carrying on of the mine safety work and other investigations in which the Bureau of Mines is interested.

The State of Pennsylvania has appropriated $25,000 for co-operation in establishing this experiment station, and has appointed a state commission which has tentatively approved the plans.

The group consists of 3 main buildings facing Forbes St. The central building of the group, the Mining Building, will be 3 stories in height, flanked by 2 main buildings, one the Mechanical and the other the Chemical building. In the rear of these and inclosing a court, will be the Service Building. Beyond the Service Building and spanning Panther Hollow and thus connecting the Bureau of Mines buildings with the Carnegie Schools, will be 2 buildings over the roofs of which will pass the roadway from Forbes St. to the Carnegie School buildings and Schenley Park.

Between the main group and the power and fuel group will be the entrance to a series of mine shafts. One of these will be used as an elevator to carry heavy material and passengers; another will be for tests of hoisting ropes and similar mining appliances; another will be an entrance to tunnels extending under the buildings and in which mining experiments, such as fighting mine fires, will be conducted.

The portion of Panther Hollow above the Power buildings will be arranged as a Miners' Field, the slopes of the ravine being utilized as an amphitheater which will accommodate 20,000 spectators who may assemble here to witness demonstrations and tests in mine rescue and first-aid.

The Bureau has accomplished a great deal in the way of improving the safety to workmen in mines and by the erection and equipment of these buildings considerable impetus no doubt will be given to this work.

Retubing Boilers

CUTTING OUT, REMOVING, REPLACING AND EXPANDING, WITH THE TOOLS TO USE. BY J. C. HAWKINS

ONE of the most disagreeable duties in a boiler room is renewing tubes. It usually has to be done during a short shutdown while the boilers are still hot, or on Sunday, and as a rule much trouble is experienced in getting the old tube out.

In a fire-tube boiler, the location of the tube will govern, to some extent, the procedure in getting it out. If the tube is located so that it can be taken out of the lower manhole, it can be cut off at one end, just inside the head, with a bent chisel or with an inside tube cutter shown in Fig. 1, if one is at hand, and taken out in one piece. The bead on the outside of the head is then cut off with a chisel and the short piece of tube ripped through the seat with the ripper shown in Fig. 2. In ripping the tube through the seat, the workman should be careful not to cut the seat. After the cut is made, the piece may be knocked out.

If the tube is located so that it can not be taken out at the manhole, it must come through the tube hole. Tubes are usually covered with hard scale and bagged or blistered, making the diameter larger than that of the hole. It may save some time, to run the tube cleaner through the tubes to be taken out before cutting them, as this will knock off the greater part of the scale. Striking it close to the head with a hammer will also

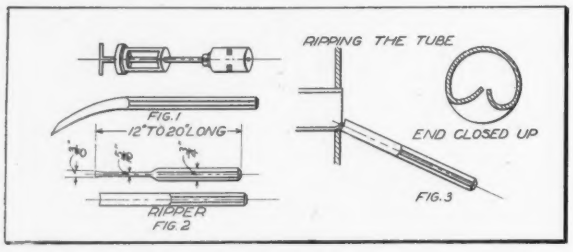


FIG. 1. ROLLER TUBE CUTTER AND CUTTING CHISEL
FIG. 2. RIPPING TOOL FOR SPLITTING THE TUBE
FIG. 3. RIPPING AND CLOSING THE TUBE END

help to loosen the scale. When the tube is to come through the tube hole it is not cut inside, but the ends are ripped, and closed up, then the tube is pulled through the hole. This may be accomplished in different ways, the one to be chosen depending on the circumstances, and the tools at hand. It may be forced out a few feet by driving on the back end with a sledge hammer and block of hard wood, but there is little room to insert a long block to drive it far. It may be possible to get a flat bar down between the tubes by going in on top of the tubes and swinging the bar against the end of the tube.

A chain hoist or block and fall hitched to the projecting end of the tube and to a convenient post, will help, and sometimes turning the tube with a pipe wrench will tend to screw it out of the sheet, especially if the chain hoist is hitched to the projecting end to help it along. After it has been pulled out a few feet, the projecting end may be cut off with a pipe cutter, which makes it easier to handle. As the back end will be battered up in driving it out, it will not come through the hole without being closed up, which can be done with a hammer and chisel. More damage may be done to the tube sheet in getting the old tube out than from operating the boiler several years, and for that reason, especial care should be taken in taking the old tube out.

After the tube is out, the seat is cleaned and the new tube slipped in. Some engineers recommend that the ends of new tubes be annealed before putting them in, by heating them to a dull red in a charcoal fire and cooling slowly, the idea being to make them more homogeneous, and to prevent them from cracking while being expanded. This is not necessary, if precautions are taken to put the tube in properly so that it will not be stretched excessively in expanding.

In some fire-tube boilers, especially of the locomotive type, the tube hole is larger than the tube, and a copper ferrule is used to fill the space. This is first rolled in lightly, then the tube is rolled in tight. In a horizontal tubular of the usual design, these ferrules are not required unless the hole has been stretched by repeated

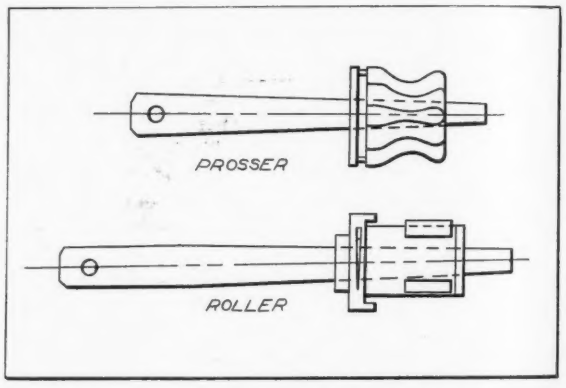


FIG. 4. WEDGE AND ROLLER EXPANDERS

expanding. In such a case, it is necessary to fill up this space to prevent cracking the tube in expanding, which is done by using thin strips of copper about 1 in. wide to fill up the space. Whatever material is used for this purpose should be soft, to prevent stretching the tube sheet, and copper seems to give the best results.

For a fire-tube boiler, the tubes should project through the sheet about ⅜ in. on each end to allow for beading over after the tube is expanded. If they extend through more than this, they are liable to be cracked in beading. Before starting to expand the tube, see that both ends extend through the proper distance, then have a helper hold the front end tight with a bar to prevent it from slipping while the rear end is being rolled.

In placing the expander in the tube, care should be taken to have it extend about the same distance each side of the sheet, and see that the tube is expanded gradually all around to prevent splitting.

There are 2 types of expanders, the Prosser and the roller, see Fig. 4. The former does its work by means of a turned taper wedge driven into the center of a block of the proper shape which is made up of a number of wedge sections held together by a spring; driving in the pin, forces these out to a greater diameter. The roller type gives the better results, and is the one generally used. This consists of a frame carrying 3 steel rolls which are forced against the tube by a taper plug. The plug is tapped lightly to force the rolls out against the tube, and the expander is turned to roll the tube out against the seat. The roller expander has the advantage that if the tube seat is not perfectly round, the tube will be expanded tight into all the cavities.

One difficulty sometimes encountered in use of the roller expander by an inexperienced man is that, if the tube is a loose fit, the plug is driven in snug to start, which will stretch the tube at 3 points, and in turning the plug the rolls will not move out of these spots. If this should occur, the rolls will have to be loosened and set in a different place, and the tube gradually rolled until these spots are worked out. Sometimes this causes a deal of trouble; but if the plug is tightened up gradually as it should be, no trouble will be found.

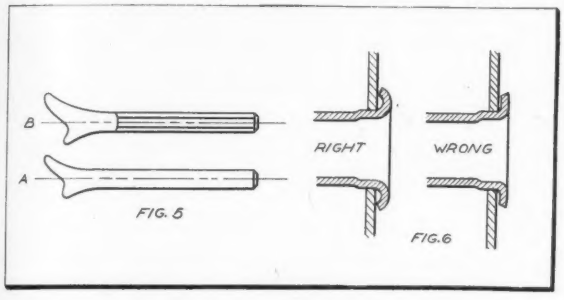


FIG. 5. BEADING TOOLS

FIG. 6. RIGHT AND WRONG BEADING OF TUBE ENDS

It is possible to roll a tube too much; this will cause it to become excessively thin at the seat, and sometimes the workman is at loss to know just when to stop rolling. When the roller expander is used, as soon as the tube is rolled out tight all around, the rolls will seem to be turning on a smooth surface, and the plug will be tight when tapped with the hammer. It is best to stop at this time and examine the seat. If there appear to be any spots that are not rolled out tight against the seat, the expander should be put in again, care being taken to get it set as before.

After the tube has been expanded, the ends should be beaded over tight against the sheet, which can best be done with beading tools made as shown in Fig. 5. The bit of these tools should be about $\frac{3}{8}$ in. wide. Tool A is used first to draw the edges over, striking it lightly to prevent splitting, and working all around the end, and tool B is used to draw it down flat against the sheet. Figure 6 shows proper and improper methods of beading the end, and also the way a properly rolled tube will look.

Water-tube boilers are built in so many different shapes that no set rule can be applied to all boilers. In the Babcock and Wilcox, Heine and some others, all the tubes except the bottom and top rows have to come out through the tube hole. The bottom row, however, is most likely to give trouble from bagging, and usually has to be replaced at shorter intervals than the others.

The easiest way to get a tube on the bottom row out is to rip it at both ends through the sheet, with the ripper shown in Fig. 1, which is made long enough to extend through the hand-hole, and close the end up.

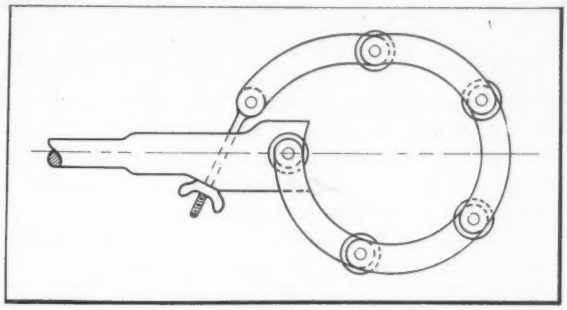


FIG. 7. FIVE-WHEEL CUTTER FOR WATER TUBES

The tube may then be cut in pieces and easily taken out through the fire box and combustion chamber when the boiler has vertical baffles. If the boiler has horizontal baffles on the lower tubes, it need not be cut, but may be taken out whole. The easiest way to cut the tube to get it out is with either an inside tube cutter, or a 5-wheel pipe cutter, shown in Fig. 7; but it may be done with a plain 3-wheel pipe cutter by turning the tube with a chain pipe wrench. Tubes above the bottom row must come through the tube hole, and therefore must not be cut off inside, as it would be almost impossible to get the pieces out.

Tubes in a water-tube boiler are subjected to a more intense heat than in a tubular boiler, and are usually bagged. When these tubes have to come through the tube hole, it is sometimes a tough proposition to get them out. If the enlarged part can be reached with a long chisel between the tubes, it may be split and closed up to go through the hole, and will be taken out in the same manner as fire tubes.

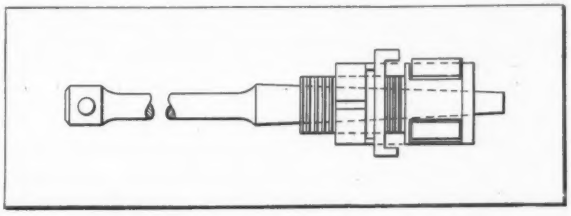


FIG. 8. TUBE EXPANDER FOR WATER TUBES

In some instances when the tube was badly bagged, the writer found it necessary to put a clamp on the tube outside the header, and use a jack screw on each side to draw it out.

Tubes in water-tube boilers are not beaded, but are "belled" or flared out at the end outside the header. This is done by first expanding the tube in its seat, then pulling the rolls out so that the end, projecting beyond the header from $\frac{1}{4}$ to $\frac{3}{4}$ in., will be expanded to a diameter of about $\frac{1}{4}$ in. larger than the tube. In putting in the new tube, care should be taken to replace the baffle walls, which may fall down when the old tube is taken out.

The best expander for water-tube boilers is made as shown in Fig. 8, which is similar to that for fire tubes, except that the end carries an adjustable collar so made that it may be set at any distance from the rolls. The advantage of this feature is that the center of the rolls may be set directly over the sheet, regardless of the distance the tube extends through the sheet, and to bell the tube the collar is set close to the rolls to prevent their slipping into the tube. The plug used in this expander is made long enough to extend through the header to give plenty of room for operation.

Tubes of vertical boilers of the Cahall and Wickes types are removed through hand-holes located at proper points and new tubes are put in in the same manner as in horizontal water-tube boilers, except that the tube must be wedged up in place in the mud drum by blocking up in the mud drum while the top end is being rolled.

In the Stirling boiler (except in some of the older types), the tubes are so spaced that any tube may be taken out without disturbing any other tube. These boilers are built to fit the conditions; that is, a boiler of given horsepower may be wide and low or narrow and high. All tubes are not the same shape or length, and it is necessary to order them from the manufacturers of the boiler, stating the size and type of boiler, also for which row they are wanted. The rows are numbered from back to front, No. 1 row being the one nearest the back wall between the back steam drum and the mud drum; No. 2 row is next to it towards the grates, etc. In other words, they are numbered in the opposite direction to the travel of the gases.

To get a tube out, rip the lower end about 6 or 8 in. and the top end 4 in.; close them up and push the tube down into the mud drum until it comes free of the steam drum. Twist it around until it will pass between the tubes and out through the proper door in the setting. This is sometimes quite a puzzle but, unless badly warped, the tube will come out all right. New tubes are marked "Top" on the end that goes into the steam drum, and must be put in this way. Each tube is also marked with the number of the row in which it belongs, and will fit no other row.

Block the tube up in the mud drum and roll as described for fire tubes, being particular to get the bend in line with the adjacent tubes to allow them to be taken out when necessary. The first 2 or 3 rows next the fire are most likely to give trouble, and are generally badly warped, which sometimes gives trouble in getting them out. These tubes should be belled, but not beaded. In any boiler, whether fire or water-tube, where the seat is in good condition and the tube is properly expanded, there is small chance of leakage in the new tube; but, as a precaution, the boiler should be closed up, a hydrostatic pressure at least equal to the working pressure put on and the ends examined for leakage. The usual test pressure used by boiler inspectors when testing a boiler is 1½ times the working pressure; but unless extensive repairs have been made or a large number of tubes put in, or there is other good reason to doubt the work being properly done, it is unnecessary to subject the boiler to this excessive strain.

The Ripper vs. Other Methods of Removing Boiler Tubes

By C. M. William

IN removing tubes from a boiler, it is very important that the headers should not be destroyed. I have seen an engineer use a ripper to remove tubes, and due to the lack of the required knowledge for the proper use of the tool, the header was so badly ground that it eventually had to be replaced to stop the leaking around the tube.

The ripper is a plain, simple and necessary tool for the quick removal of a tube. In fact, the ripper (Fig. 1), an oyster knife (Fig. 2), a hammer, a little elbow grease are the only tools necessary for the rapid and successful removal of boiler tubes.

Figure 3 shows the proper method (with the ripper in position) of removing a tube from a B. & W. or Worthington water-tube boiler. Remove the header cap, either above or below, also the one for the tube to be removed; insert the ripper as shown, and drive the side of the tube end away from the header far enough to admit the point of the oyster knife. Then remove the ripper and insert the oyster knife, as shown in Fig. 4, and collapse the end of the tube until it is entirely free

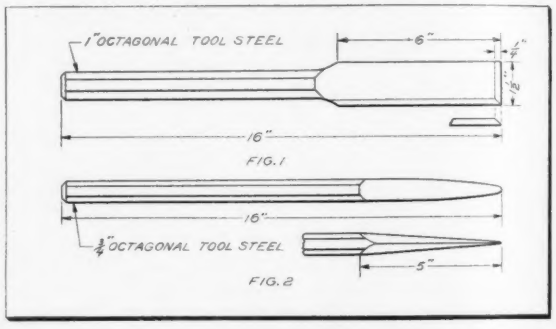


FIG. 1. RIPPER USED TO REMOVE TUBES
FIG. 2. OYSTER KNIFE

from the header. After the opposite end has been treated in the same manner, the tube can easily be withdrawn, since there are no swelled ends to interfere.

To remove the mud and steam drum nipples, the same tools are used. With the ripper, split the nipple close to the header (and drum) (Fig. 5), hold it, first nearly at right angles to the nipple until it is broken through, and then at about the angle shown, and drive away the tube to admit the point of the oyster knife; the end is then collapsed and can easily be removed (Fig. 6).

Figure 7 shows the wrong way to use a ripper. It is readily seen that it would be very difficult for one to rip or slot the tube without cutting a groove in the header; but if the method described above is used, there need be no fear, even by the beginner, of injury to the header, because the cutting edge is always at an angle with the surface of the hole into which the tube is expanded, the same instructions will apply to the removal of a tube from any boiler.

There is on the market, a tube cutter, composed of a stock and 3 cutters, so arranged that they can be expanded outward by means of a mandrel or taper pin, which cuts the tube off just inside the header; but when tubes are nested as in the case of water-tube and other boilers, an inside tube cannot be easily removed, due to the fact that during the process of cutting, the end has become expanded to such an extent that it will not pass out freely through the hole in the header. After the tube has been cut off, the amount of work necessary to remove the end remaining, is about as great as before the tube was cut off.

I have seen tubes removed by means of a draw bar, composed of a large iron bar, 6 or 8 in. longer than the tube, threaded on one end to 16 or 18 in., and provided with a nut, the other end is also provided with a nut and a strong washer, whose outside diameter is slightly less than the hole into which the tube is expanded. A small bar or other tool is used to crush in the ends of the tube slightly. The bar is then inserted and a bridge

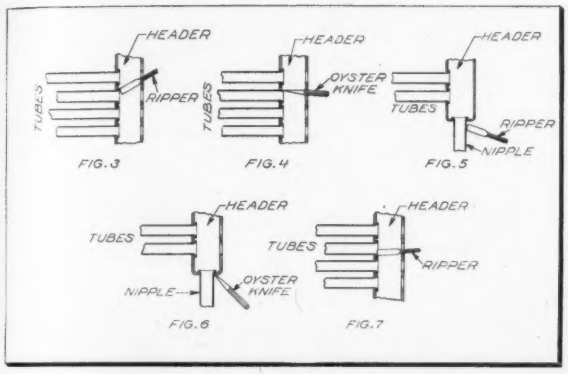


FIG. 3. PROPER METHOD OF REMOVING TUBE WITH RIPPER
FIG. 4. SHOWING METHOD OF INSERTING OYSTER KNIFE
FIG. 5. SHOWING METHOD OF SPLITTING NIPPLE
FIG. 6. COLLAPSING END OF NIPPLE WITH OYSTER KNIFE
FIG. 7. A WRONG WAY OF USING RIPPER ON BOILER TUBES

arranged against the head so that the tube will be free to move, while the washer is placed against the other end of the tube. The nuts are then put on and a strain applied.

The objections to this method are: That the strain on the headers is very great, and, should there be no damage done to them, other tubes are liable to be started which would cause them to leak; and again, the metal used in the manufacture of tubes is very soft, and after it has become weakened from wear, it may be crushed and bent so badly by the strain upon it that it could not be removed without additional work and trouble.

In my opinion there is nothing more simple, convenient nor more rapid for removing tubes from a boiler, than a ripper, an oyster knife and a hammer.

IN DETERMINING the amount of 2-in. piping for direct expansion cooling of an ice storage room, the common rule is to use one lineal foot of 2-in. pipe for every 15 to 18 cu. ft. of ice storage space. Another rule is that the ceiling should be covered with 2-in. pipe, spaced 12 in. on centers, which, for a room 10 ft. high, gives about ⅓ more piping than the first rule mentioned.

A Power Plant Record Book

BY ROY W. EVES

ONE of the essentials to the success of an engineer in charge of a power plant is a thorough knowledge of his plant in the broadest sense of the word. First, there is the general knowledge of the fundamental principles of economical steam generation and application, and of compressed air, electricity, refrigeration and hydraulics. Second, there is the knowledge of the thousand and one details of design and operation which differentiate his particular plant from the thousands of other plants. The first mentioned knowledge can be obtained from some or all of the following sources: Experience, technical journals, books, or the "Spare Time Universities" whose existence is a standing rebuke to the man who whines because he is handicapped by lack of education. The second mentioned knowledge can, of course, be gained only after the man is in charge of the plant, sometimes years after, and has, to a certain extent, to be learned over and over again every time he changes his position.

In any plant of any size, it would require a man with a phenomenal memory to carry all of these minor details of information about the apparatus under his charge that it is necessary at times to use. In addition, there are many details that, while needed less frequently, are nevertheless just as necessary to have available at a moment's notice. A power plant in one respect is like Habit, of which it is said that it is either your master

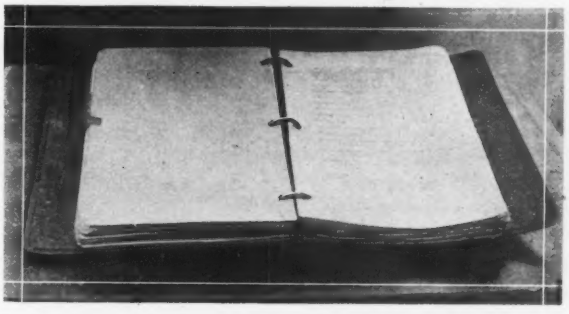


FIG. 1. POWER PLANT RECORD BOOK

or your servant; to make it your servant, you must first thoroughly and intimately know it. There is usually around a power plant a mass of special information to be found in pamphlet, catalog, letter, memorandum, name-plate, written on the wall, marked on machines, tucked away in corners, shelves, pockets, or pigeonholes, and in inaccessible or forgotten books somewhere in the main office. It was to collect, classify, condense, and render instantly accessible this mine of valuable local data, that the writer figured out the simple system here described.

To start the system, all that is required is a loose-leaf binder similar to the one shown in Fig. 1 and described by the dealer from whom this particular binder was purchased as a "National Simplex Loose Leaf Price Book, No. 4251," with 6 by 9-in. sheets and an alphabetical index, and a punch for punching ¼-in. round holes. Of course, any size or style of binder available

would answer the purpose; but experience has taught that the one described is the most adaptable to the various conditions to be met with in use. This kind of binder makes the book a complete unit if but 10 pages are needed, as for a very small plant. It will hold as many as 250 pages for the medium sized plant, while all that is necessary to adapt it for use in the largest or most complicated plant is to procure additional binders.

The book should be divided into sections by the alphabetical index pages gotten with the binder, or by

AIR COMPRESSOR
No. 93

AIR COMPRESSOR,

Mfgrs, Blank Co.
Serial No. 2925
Local Shop No.93
Size 12 & 19 - 12 by 14
Mfgrs. rating: 690 cu. ft. at 150 r.p.m.
" " 117 hp. at 100 lb. Steam Press
Mfgrs. description:
Type GDSC
Duplex
Steam Driven
Two Stage
Fork Frame
Base Intercooler
Intake Valves, Mechanical
Discharge Valves, Poppet
Gardner Speed and Pressure Regulator
Steam Supply Connection 4½"
Steam Exhaust " 6 "
Air Inlet " 6 "
Air Discharge " 3½"
Flywheel 66", Wt. 2700 lb.
Floor Space, 14' 4" by 7' 11"
Received Nov. 1907
Orig. Cost $2200
Foundation and Piping Plan No. A2332
Packing sizes:
Air and steam rods 2" by 3½"
Valve rods 1¢ by 1¢

FIG. 2. SAMPLE PAGE OF RECORD BOOK ON AIR COMPRESSORS

sheets of heavier paper with easily made tabs pasted on the edges. The sections used in the book here described are as follows:

A Air Compressors.
Air Piping System.
Air Reservoirs.
B Boilers.
C Controllers, Electric.
D Dimension Sheets, Misc.
E Engines.
F Fans, Electric.
Fan, Draft.
Fire Fighting Apparatus.
G Generators.
Gears.
H Heaters, Feed Water.
Heaters, Shop and Office.
Heaters, Electric.
I Illumination (Record of arcs and incandescents in service).
L Lubricators.
M Motors.
Magnet, Lifting.
P Pumps, Feed Water.
Parts, Misc.
Packing Sizes, Cat. Nos., Etc.
R Rheostats.
S Starters, Automatic.
W Water, Feed—Analyses.

In each of these sections, there is a separate sheet for each piece of apparatus with full detailed description and all available information, results of tests, etc. Figure 2 shows a sample record of information.

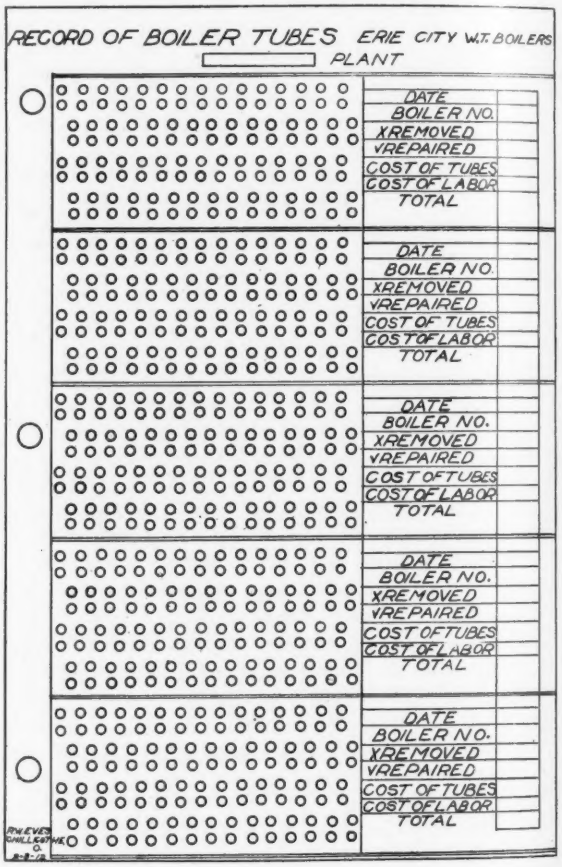


FIG. 3. SAMPLE PAGE OF RECORD BOOK ON BOILER TUBES

The next sheet to this one covers date, costs, and extent of all repairs made to that particular machine. This sheet is of value and interest because it shows at a glance whether a machine or piece of apparatus is becoming too expensive to maintain and will sometimes show whether one man will operate with fewer repairs than another. A separate record of this kind also enables the engineer to learn the cause of an increased total maintenance cost or to explain intelligently the necessity or economy of replacing old apparatus with new and more efficient.

It would be impossible to go into detail as to the information contained in a book of this kind, as the one described contains 225 pages and over 9000 separate items of data and information. A few illustrations will suffice, for the average engineer has more than enough intelligence to grasp the idea and to apply it to the particular need of his plant. Figure 3 shows a tube renewal record. These are blueprints made from a tracing and trimmed and punched to the proper dimensions. When a tube is rolled, or renewed, it is marked in the proper place on the sheet, together with the date, cost, etc., and enables one to learn in which boiler, in what part of a boiler, or at what time of the year tubes leaking or renewed are most frequent.

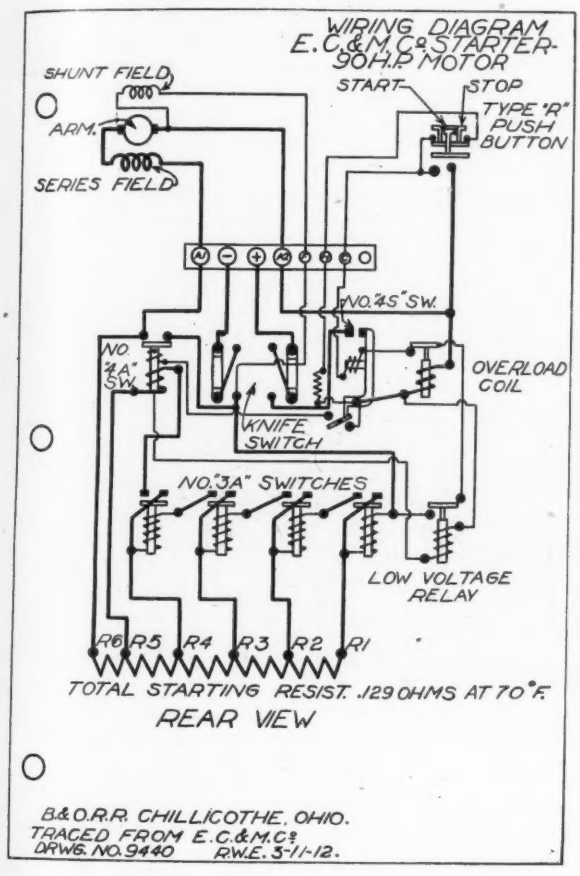


FIG. 4. SAMPLE PAGE ON CONTROLLER CONNECTIONS

Figure 4 shows one of the sheets under "C," being a connection diagram of an automatic motor starter. There is one of these diagrams for each motor, controller, and electrical device in the plant. Some of them were obtained from manufacturers in such shape that they merely had to be punched and put in the binder; some had to be redrawn to smaller scale, and some had to be traced out from the apparatus itself and drawn. Having them in this shape enables them to be studied at leisure and also makes them instantly available in case of trouble or in moving or changing the connections. Much time and worry is often saved by this arrangement.

Under "R" is collected information concerning cost, catalog numbers, etc., of miscellaneous repair parts. In obtaining repair lists and catalogs from manufacturers, many of the sheets will be found to coincide with the size of this book and merely have to be punched and are ready for insertion. When they are not, illustrations and lists can be cut out and pasted on a sheet of the proper size.

An arrangement of this kind will be found to be infinitely quicker and more convenient than searching frantically, and often unavailingly through a drawer of several dozen or hundred leaflets, pamphlets, bulletins or catalogs for information, or striking a match in a dark corner while in an inverted position trying to read a name plate, or telling the boss that you will have that information he has asked for as soon as you can figure it up or find someone that remembers something about it.

A few minutes a day, just at the time that certain little pieces of information are available, and a few letters or postals to the makers of the various apparatus in your plant, and before you are much older, you will be wiser and have your book done.

If you have the proper fraternal engineering spirit and are broadminded, it will give you a certain thrill of pride and satisfaction to be able to turn over the contents of a book like this to your successor, no matter how unworthy you may think him to be, and to say: "Well, now I have shown you everything about the plant there is to see, I will turn over a little book to you here that will make you as familiar with the plant with 2 days' study as it took me 2 months to be."

IN SPEAKING OF the subject of power for steel mills before the Western Society of Engineers, F. G. Gasche, of the Illinois Steel Co., presented some interesting figures. Based upon experience with a station containing 2000-kw. gas-engine-driven units, and upon recently published steam turbine data, he stated that the turbines showed a rate of fuel consumption 37 per cent higher than the rate for gas engines, under the same load conditions. He also stated that a gas engine installation for steel mills would cost about $100 per kw., while a steam turbine installation would cost about $65 per kw. With fuel cost of 0.003 cent per kw.-hr., and for 6000 hr. yearly service, the fuel cost per kilowatt for the turbine plant would be $18 a year, and for gas engine plant, $13.10 a year. This shows $4.90 fuel saving for the gas engine; but, taking fixed charges on both plants at 15 per cent, the yearly cost per kilowatt would be $8.25 for the turbine, and $15 for the gas engine, or $6.75 in favor of the turbine installation. Comparing this with the $4.90 fuel saving for the gas engine plant, shows $1.85 per kw. per year net in favor of the turbine installation. Mr. Gasche stated that operating expense and other items will considerably increase this margin. Mr. Gasche and other speakers felt that the uneven crank effort of the gas engine was a hindrance in making the best product in steel mill, and that flywheels large enough to overcome this unsteadiness would be commercially and physically preposterous. In closing, he advised that when large amounts of by-product gas are available for power purposes, the gas be used under steam boilers, and turbines used for driving the generators.

The Panama Hydro-Electric Development

GENERATION OF ELECTRICAL ENERGY AT PANAMA FOR LIGHT AND POWER SERVICE

IN the artificial Gatun Lake, fed by the Chagres River, is a great water storage which not only carries vessels the greater part of the way across the Isthmus on an elevation of about 85 ft. above sea-level, and provides water for raising and lowering them gently through the Gatun, Pedro Miguel and Miraflores locks, but it also has afforded an excellent opportunity to generate electric current for lighting the canal, for operating the gigantic gates, and other locking machinery, and for the propulsion of locomotives towing ships through the locks. For this reason the hydroelectric station was built at the Gatun spillway dam.

Coal handling plants at both ends of the canal, the machine shops, water works, drydocks and in the future the trains on the Panama Railroad, all will utilize the current generated at this plant; hence, to insure continuity of service in case of accident, the steam-electric station erected at Miraflores a few years ago, to supply power for construction work, will be ready to pick up the load when necessary.

POWER AND DISTRIBUTION EQUIPMENT

THE GENERATING equipment consists of the 7500-k.v.a., 2200-volt hydroelectric plant at Gatun and the 4500-k.v.a., 2200-volt steam-electric plant at Miraflores connected by a double 44,000-volt transmission line with Cristobal and Balboa.

The distributing system consists of 44,000 — 2200-volt substations at Miraflores, Gatun, Cristobal and Balboa; 2200 — 240-volt transmission stations for power, traction and light at Gatun, Pedro Miguel and Miraflores locks; 2200 — 220 — 110-volt transformer stations for the control boards at the locks; and stations at Cristobal and Balboa for the coal handling plants, machine shops and drydocks.

Should the demand of the Panama Railroad overtax the capacity of the Gatun hydro-electric station, provision has been made to give this plant an ultimate capacity of 12,000 kw., the 3 outlet pipes in the dam having been installed along with the original pipe lines. Figure 1 is a panoramic view of the Gatun station under construction, showing pipe lines and turbines erected, Fig. 2 is an interior view of the hydro-electric station.

GATUN GENERATING UNITS

EACH OF the 3 2000-kw. main generating units in the hydro-electric station is driven by a special 50-in., vertical, single runner, Francis turbine manufactured by the Pelton Water Wheel Co., each turbine having a maximum capacity of 3600 hp. when operating at 250 r.p.m. under an effective head of 75 ft. The turbines are located at such a depth that the center of the runners is 20 ft. above the tail water.

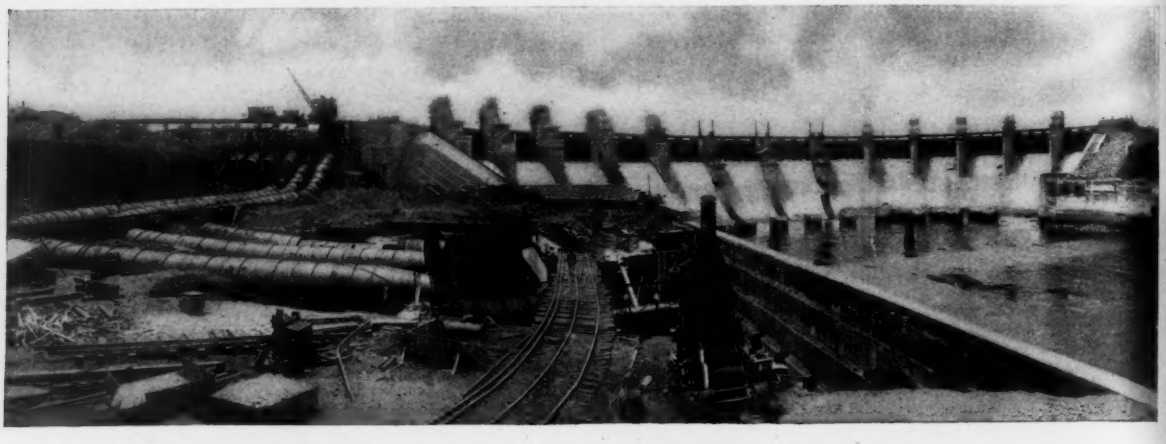


FIG. 1. PANORAMIC VIEW OF THE GATUN STATION UNDER CONSTRUCTION WITH PIPE LINES AND TURBINES

These turbines, which are so designed that the runner exerts an upward thrust of 20,000 lb. when working at full capacity, thereby relieving the thrust bearing of that amount of load, are of the spiral case type and are fitted with heavy cast-iron distance rings which carry the generators.

The weight of the revolving part of each generator and turbine is carried on a roller thrust bearing, oil for which is supplied by a small pump geared to the main turbine shaft, a tank being provided below the pump to receive the overflow from the bearing. As the oil returns to the suction tank, it passes through the lower guide bearing on the main shaft and lubricates it.

Runners of these turbines are made of a special bronze and weigh approximately 7000 lb. each. They are bored taper and are held in place on the lower end of the shaft by means of bronze nuts, and have the surfaces of the runner vanes hand finished to reduce hydraulic losses.

Generators and Exciters

Each of the 3 main 3-phase vertical revolving field type General Electric Co. generators is rated at a guaranteed continuous capacity of 2000 kw. at 0.8 power factor, 2200 volts, and 250 r.p.m. and with an overload rating of 2500 kw. at 0.8 power factor for 2 hr. The exciters, likewise General Electric, have a capacity of 50 kw. at 125 volts, and are each capable of furnishing exciting current for 2 generators under maximum guaranteed load. Each unit, generator and exciter weighs approximately 65 tons.

Current limiting reactances are provided to give 5 per cent reactive drop at 2500 k.v.a., 2200 volts, 3-phase, 25-cycle. While the generator windings are sufficiently rigid to stand the strain of a short circuit under full load, these reactances will reduce the shock on the windings and will also serve to render the operation of synchronizing the machines easier and safer.

Two motor generator sets, each consisting of a 100-kw., 125-volt generator at 500 r.p.m., direct-connected to a 150-hp., 2200-volt 25-cycle squirrel cage type of induction motor, are mounted on a common base plate, provided with 3 bearings and are used for excitation purposes and also for charging the control battery.

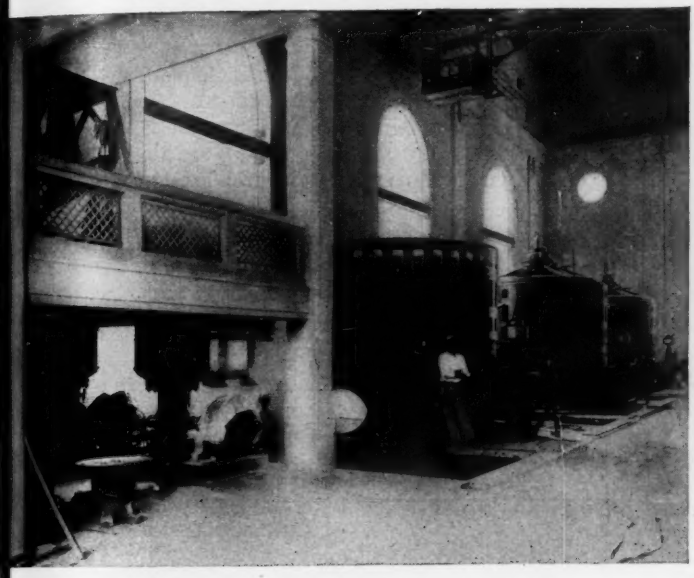


FIG. 2. INTERIOR OF HYDRO-ELECTRIC STATION

Instrument and Control Board

The main switchboard is of the bench board type, with vertical rear board for relays, watthour meters, graphic instruments and the control battery equipment. The space between the front and rear board is enclosed by grill-work with doors at each end, and a metal molding extending along the floor and the top of the board gives a finished appearance to the whole. Figure 3 well illustrates this board, which was made by the General Electric Co. The first panel from the left in the bench board controls the exciters, the next 3 the generators and the remaining 4 the 24 feeder circuits, the system of connection being represented by dummy busses of polished copper on top of the bench.

A generator voltage regulator, transferable to either of the 2 sets of busses is installed on a separate pedestal which also carries the synchroscopes and clock.

Exciters are controlled from the bench board; but the electrically operated exciter switches and field switches are mounted on a separate board so located as to make the exciter connections as short as possible, thus eliminating the exciter busses and the main connections from the control board, but leaving the control of the whole equipment in the hands of the operator.

Bus and Switch Compartments

These are located on 2 galleries, the upper one carrying the control board, the generator reactances, compartment for generator current and potential transformers and the generator oil switches; while on the lower gallery are located the feeder oil switches and the compartment for the instrument transformers. On the main floor just below this gallery is the cable vault with racks for the feeder cables.

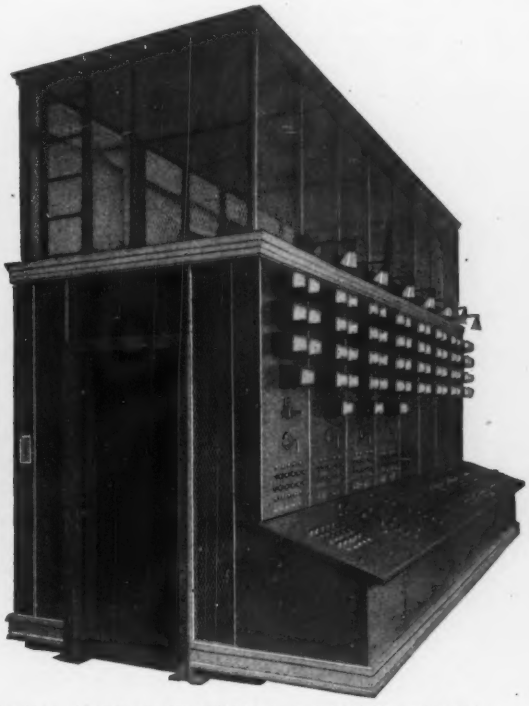


FIG. 3. GENERAL VIEW OF BENCHBOARD IN GATUN STATION

All compartments are built of concrete with flameproof doors. Even where the current is very small, busses and connections are made of solid copper rods of sufficient size to give a rigid construction, with connections and all joints heavily insulated with varnished cambric to make them perfectly safe.

At the plant of the Union Brewery in St. Louis, an 8-ton flywheel, 24 ft. diameter at 60 r.p.m., overspeeded from some cause, on June 29, and partly wrecked the refrigerating plant, one 3-ton section escaping through a window and another going through a 4-in. concrete ceiling and wrecking tanks containing 40,000 lb. of ammonia.

Electrical Machinery and Appliances

For Generating, Transmitting and Using Current

A Double-Throw Flush Switch

By Irving W. Booth

IN the office, it is often necessary to work overtime and evenings when the power house is shut down. We therefore decided when refurnishing to connect in the central station service, and put in throw over switches. In this way light could be obtained from the street mains when our own plant was not in operation.

Both circuits are 3-wire, and the office was all connected up on a 3-wire system. After the job was done and the decorations finished, we proceeded to install the switches. We had some 3-pole double-throw baby knife switches on hand, and placed one in the inner office. When we came to the outer room we struck a snag.

The powers that be, insisted that there should be no knife switches on the walls. They might be good enough for the mill, but in the office it must be flush switches.

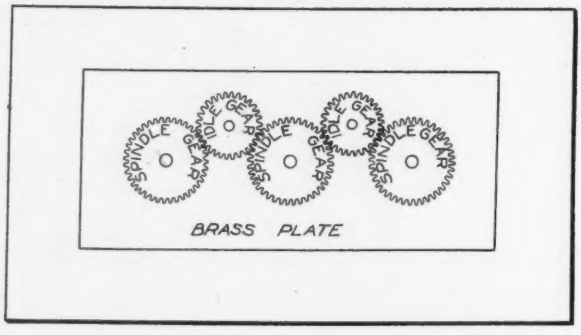


FIG. 1. GEARING OF DOUBLE FLUSH SWITCH

Who ever heard of a 3-pole double-throw snap switch?

However, it had to be done, and here is the solution:

From 3, 4-way, flush, chandelier switches the spindles were removed and lengthened, so that they would stick through the backs of the switches about ⅜ in. A brass plate about 3/32 in. thick was cut just large enough to cover the porcelain bodies of the switches when placed side by side in the 3 gang position.

The brass plate was drilled to allow the 3 lengthened spindles to project through and to furnish a bearing, holding the gears in position as shown in Fig. 1. The plate was fitted with studs for the idle gears. Screws, not indicated on the drawing, held the switches in place. On each spindle as shown, was forced a brass gear 32 pitch with ⅛-in. face; as additional security they were sweated. The 2 idle gears turn free on the studs and are retained by split pins.

This gave a train of 5 gears as shown. The 3 spindles being geared together, all must turn in the same direction when any one is rotated.

The gang was then mounted in an asbestos lined box, so as to bring the face of the gears nearly flush with the wall. Obviously, the standard iron box could not be used. The box was deep enough to give plenty of clearance. To make the switches work very free, all useless contacts were removed, leaving only 3 stationary points and a pair of contacts on the spindle. Lastly, the switches were connected into the lines as shown in Fig. 2.

Since the switch has 4 positions, it has 2 off points, arranged to follow each other. A different arrangement would have given an "on" point between each "off." We consider the present arrangement the best. The first connection is made to the mill circuit as shown, so that on turning on the lights, after passing the 2 off points, they are on our own circuits. Whoever turns on the lights, finds no response to the first snap—the second

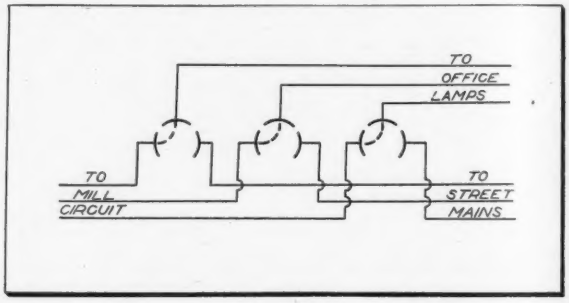


FIG. 2. DIAGRAM OF CONNECTIONS OF SWITCH

off point—but the next point lights the lamps, and they naturally stop turning. The next point will give the public service current when needed. As a further inducement to keep on the mill circuit instead of the one that spins the meter so merrily, a different voltage is carried. The street mains are supposed to be 110 volts, but the "drop" renders this only a hoped for maximum. Our lamps are ordered 116 volts, middle voltage. The mill circuit is 120, dropping at load to 118, the top voltage on lamp. No one will use town light when the mill circuit can be had, and if the lights look sick, the man furnishing the current gets the cussing out, not the lamps.

When the flush plate was put on and the buttons screwed home, the assembly was like any 3 gang flush switch outfit except that on turning any one button the other two rotate with it.

We are thankful that rotary flush switches were satisfactory. Suppose push switches had been insisted on. This is left as a problem to others as to just how it would be worked out.

Some A. C. Motor Repairs

EFFECTS OF OPEN CIRCUIT IN STARTER; SOLDERING KINKS. BY ASSISTANT

ACCOMPANYING sketch is of a starting compensator for 3-wire 3-phase induction motors, showing a common cause of trouble, where there are a large number of motors in use. In starting a motor where a compensator is used, the handle attached to the oil switch is thrown towards the back of the compensator or starting position and left till the motor comes up to speed, when it is quickly thrown towards the front of the box to running position. The consequent rolling motion of the oil switch, changing from one position to the other, has a tendency to break the line and motor leads off where they are soldered into the switch clips, Fig. 2. When these breaks occur, several things are likely to happen. Motor may refuse to start on starting side, but start and run on running side. It may start on starting side, but stop when thrown to running position. It may start on the starting side and continue to run when thrown to running position, but slow down and finally stop, when the load

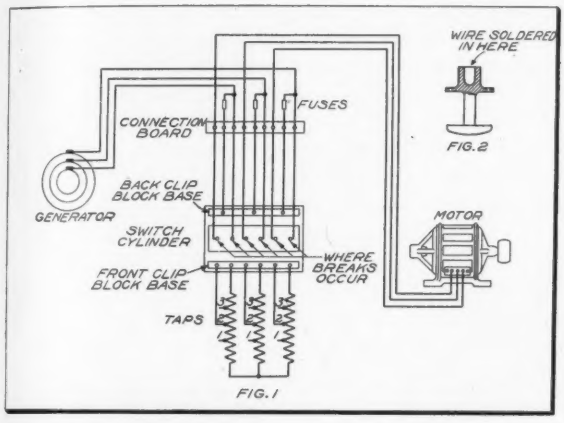


FIG. 1. STARTING COMPENSATOR CONNECTIONS
FIG. 2. SWITCH CLIP

is thrown on. Blow line fuses when attempting to start. In case of 2300-volt, 3-wire 3-phase machine, it may set fire to the box, resulting from arc caused by 3 wires breaking and not sufficient oil in the oil tank.

In case the motor does any of these things and you are not sure the wires are broken off, test all fuses and leads as near the box as possible, and if found O. K., blame the box.

First, as a precautionary measure for the good of all concerned, pull the line fuses or there may be fireworks. I know, because I tried, *once*. Next, remove the cover on the front of the box, and oil tank. Take out screws holding leads on the front clip block base to taps on coils, take out the front clip block and then, with a pair of pliers, get hold of the leads above the oil switch cylinder and try lifting up on them. Sometimes they will fool a fellow, by breaking up from the block a little. If any are found to be broken, remove the clip, clean out the hole, and feed the broken wire down through far enough to sweat into the clip again. Occasionally, one is found too short to pull down farther; this makes the job a little more complicated, as a new wire must be put in.

If the block of which the oil switch is made becomes broken, as it did for me once in a 20-hp. box, get a piece of hard maple to make a new one out of, but be sure it is thoroughly kiln dried, as the least bit of moisture in the block will cause a short between the clips, even though they are immersed in oil.

Another trouble which I now fix instead of sending to the shop, is loose pins in the rotors of induction motors. The pins are soldered into 3 rings at each end, and where motors are run for long periods under heavy overloads, become so hot that the solder melts out, leaving the rings and pins loose. I got a pan, cast at the foundry, with a hole in the center for the shaft to go through, melted up sufficient solder in the pan to do the job, thoroughly cleaned pins and rings with weak muriatic acid, and dipped in the solder. In this way, a good, neat job can be done in short order.

The first time I ever tried to do a job of that kind, I tried it with a soldering iron and got about 5 times as much solder on as was needed, besides getting the rotor out of balance. When the pins get loose, it can be seen at a glance by the excessive sparking at the ends of the rotor, where there should be none, when starting or motor pulling heavy.

Consumption of Electricity

STATISTICS given out recently by the Census Bureau indicated that the amount of electricity used in the United States quadrupled in a decade. The output of stations amounted to 11,502,963,000 kw.-hr. in 1912, compared with 2,507,051,115 in 1902, or an increase of 359 per cent.

The statistics relate to the years ending Dec. 31, for 1912 and 1907, and June for 1902, and cover both commercial and municipal electric plants. They do not include electric plants operated by factories, hotels, etc., which consume the current generated, those operated by the Federal Government and State institutions or plants that were idle or in course of construction.

Commercial stations or plants increased in number from 2805 in 1902 to 3659 in 1912, or 30 per cent. The number of municipal plants increased from 815 in 1902 to 1562 in 1912, or 92 per cent. The total income for 1912 amounted to $302,115,599, as compared with $85,-700,605 in 1902, or an increase of 252 per cent. The total expenses, including salaries and wages, in 1912, amounted to $234,419,478, as compared with $68,081,375 in 1902, or an increase of 244 per cent. The total number of persons employed in 1912 was 79,335, as compared with 30,326 in 1902, or an increase of 162 per cent.

Total horsepower of the steam engines and steam turbines was 4,946,532 in 1912, as compared with 1,394,395 in 1902, or an increase of 255 per cent. The horsepower of the water wheels was 2,471,081 in 1912, as compared with 438,472 in 1902, or an increase of 464 per cent. The output of stations amounted to 11,502,-963,006 kw.-hr. in 1912, as compared with 2,507,051,115 in 1912, or an increase of 359 per cent.

The estimate number of arc lamps wired for service in 1912 was 505,395, as compared with 385,698 in 1902, or an increase of 31 per cent. Incandescent and other varieties of lamps wired for service, however, numbered 76,507,142 in 1912, as compared with 18,194,044 in 1902, or an increase of 320 per cent.

Horsepower capacity of the stationary motors served with electric current amounted to 4,130,619 in 1912, as compared with 438,005 in 1902, an increase of 843 per cent.

A New Westinghouse Elevator Motor

GREAT mechanical strength, quiet operation, extreme reliability and excellent performance characteristics are the special features of the new alternating-current, squirrel-cage elevator motor which is being placed on the market by the Westinghouse Electric & Manufacturing Co.

A simple switch without any resistance is the only controlling device required, and the motor is started by being thrown directly on the line. It starts with high torque, so that the car is quickly but smoothly accelerated, while only a moderate starting current is drawn from the line. Figure 1 illustrates this new motor.

The frame, as shown in Fig. 2, is built up of steel laminations, securely mounted between rolled steel shields and supported by a rolled steel foot. This construction provides great strength with great compactness, so that the motor is readily mounted on the elevator machine. The stator coils are moisture-proof and can withstand a high temperature, features which well fit them for the service for which they are intended.

The bearings are dust-proof and are made to accommodate an exceedingly large shaft for the size of motor employed. The rotor is practically indestructible. It is comparatively long and of small diameter, giving it a small flywheel effect. The end rings are cast solid on the bars, and the insulation is inorganic and will, like that of the stator, withstand a high degree of heat, moisture and mechanical stress. No solder, screws or bolts are used in its construction and there is, therefore, nothing to burn out, deteriorate under heat or work loose. Figure 3 is a cut of the rotor.

These motors are made in sizes of from 3 to 20 hp., and for 2 and 3-phase, 25 and 60-cycle circuits of 220, 440 and 550 volts.

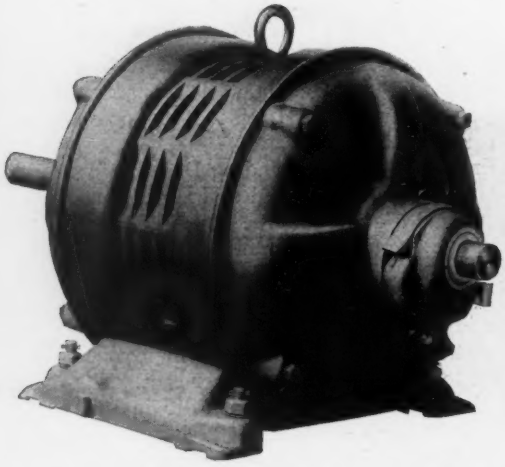


FIG. 1 NEW WESTINGHOUSE ELEVATOR MOTOR

FIG. 2. STATOR OF ELEVATOR MOTOR

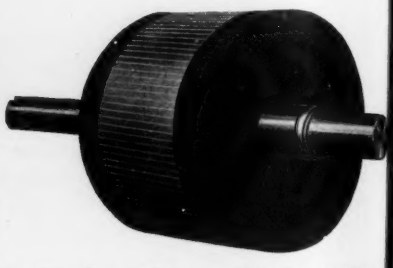


FIG. 3. ROTOR OF ELEVATOR MOTOR

New Incandescent Lighting Units

A SHORT DESCRIPTION OF NITROGEN FILLED LAMP; ADVANTAGES TO BE GAINED BY ITS USE

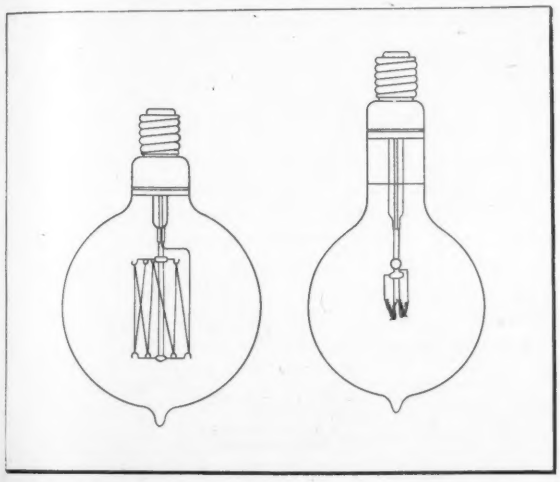
FROM the time at which the first incandescent lamp was developed and brought out for use, up to the present, there have been continuous developments resulting in more efficient and better lamps of large as well as small wattage ratings, to meet the commercial requirements of the times.

The incandescent lamp with which we are acquainted, has a filament of carbon, or in the more modern types of metal such as tungsten, contained in a globe exhausted of air. But in the new lamps just placed on the market, the globe, instead of having a vacuum, is filled with nitrogen, as the filament can be brought to a higher temperature in this atmosphere of nitrogen than in a vacuum without excessive evaporation of the metal taking place; hence, under certain conditions, it is possible to produce a highly efficient source of light.

There is, however, a disadvantage in the use of a gas filled lamp, as the gas tends to carry away the heat by convection currents set up within the globe, especially in the smaller sized lamps, as the filaments of these have comparatively greater surface areas than large filaments. Due to this, the filaments of the small lamps are cooled so effectively by the gas that a much greater expenditure of energy is necessary to maintain a given temperature than in a vacuum. A gas filled lamp of high efficiency, therefore, requires a large filament, the surface of which exposed effectively to the cooling currents of the gas is further reduced by coiling the wire on a mandrel slightly larger than its own diameter. In this way, the total heat developed in the filament by the passage of the current is localized and raises the temperature to such a degree that an extremely brilliant light is obtained.

Large filaments require large currents to heat them; hence, the gas filled lamp is specially adapted for large units. The use of gas in the bulb permits the expenditure of double the energy of the vacuum lamp in a smaller bulb. The relative sizes of a 500-watt vacuum lamp and a 1000-watt nitrogen filled lamp are shown in the figure. It will be noticed that in the gas filled lamp, the neck of the bulb is extended to form a cooling chamber and also to allow the base and socket to be kept as far away from the filament as is practicable.

As the upper portion of the bulb is hotter than that below it and sudden local cooling is caused by rain or snow on the heated glass, it is necessary to protect all lamps exposed to the weather by some form of a shield. Special glass which may be heated and suddenly cooled without danger of breaking is used in some cases for lamps designed for operation in exposed places; but, due to the difficulty of working this hard glass and inexperience in its manipulation, the bulbs made from it are less perfect than those made from the soft lead glass ordinarily used.



RELATIVE SIZES OF A 500-WATT VACUUM LAMP (LEFT) AND A 1000-WATT NITROGEN FILLED LAMP (RIGHT)

As the filament of the gas filled lamp is wound in a small, closely-spaced spiral, it takes up little room in the bulb; consequently, the light is radiated from a point source, and its high intrinsic brilliancy demands that the light be placed well out of the ordinary field of vision or be enclosed in a diffusing globe or both. Not only is the direct radiation of the filament uncomfortable and fatiguing to the eye, but it is injurious and produces temporary or permanent defects of vision. The efficiency of the lamp is such that even with diffusing globes, the lighting of a given area may be accomplished economically, and with light much whiter than that obtained from the most efficient types of vacuum lamps.

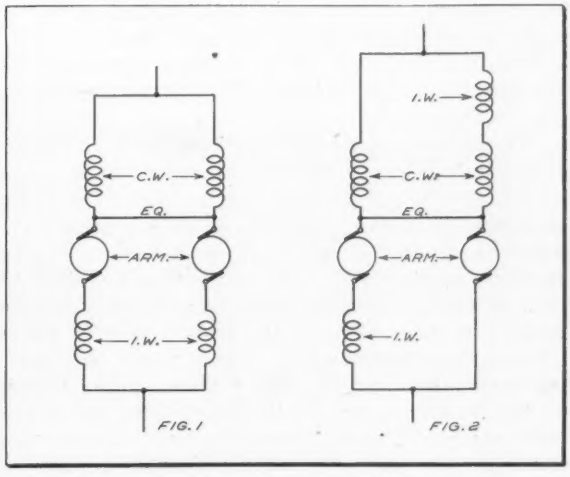
The high candle-powers obtainable, the absolute steadiness of the light and the small amount of attention required by a gas filled incandescent lamp, make it a strong competitor of the most efficient types of arc lamps. In many installations, the nitrogen filled lamp will require no attention whatever during its long life of about 1000 hr. and in other cases, the only attention is the cleaning of the bulb or enclosing globe in order to get the best effect; thus the power cost and the prorated cost of the lamp are the only ones to be considered. Variations in voltage have about the same effect on the gas filled lamp as on the older form of lamp with tungsten filament; while changes in the frequency of alternating-current systems will have less effect on the gas filled lamp than on the corresponding vacuum lamp because of the temperature equalizing effect of the gas.

Electrical Correspondence

Inter-Pole Exciter Trouble

IN A power plant situated along the banks of one of our great rivers which every spring is the scene of more or less of a deluge, were installed 2 compound wound interpole generators having similar characteristics and adjusted for equal degrees of compounding.

During a recent "high" period of this stream the water rose to such an extent as to flood the entire plant and among the apparatus damaged were the 2 interpole exciters. After the water receded, they were dismantled, cleaned and dried and as soon as possible reassembled and put into operation, but it was noticed that these 2 machines, which formerly operated in parallel, refused to do so now. When either one was generating alone, all was well, but as soon as an attempt was made to parallel them, their circuit breakers would open with a report resembling that caused by a short circuit.



FIGS. 1 AND 2. CONNECTIONS OF INTER-POLE EXCITERS BEFORE AND AFTER "FLOOD"

After many hours of perplexity as to the cause of this trouble an inspector employed by one of the large electrical manufacturing companies discovered that the field connections, which previous to the flood had been connected as shown in Fig. 1, were now connected so that one machine had its compound and interpole windings connected so as to equalize through both windings, consequently causing it to take more than its share of the load. Figure 2 shows the error in connecting up the machine, which was quickly rectified, when discovered.

J. A. HORTON.

Maltreatment of Apparatus

MERELY TO show in what condition some electric motors and generators are operated, I relate the following:

At one time, I was called to examine a 30-hp., direct-current motor, where the brushes sparked badly under full load, as well as with no load. In examining the motor, I found that there was little tension on most brushes; in fact, on some there was no tension at all, which was due to the fact that the brushes had not received any attention for a long time when, of course, the wearing away of the brushes reduced the tension on them. Some brushes were worn down so far as to allow the lower side of the brush holder to come in contact with the commutator surface.

The commutator was smoothed up with a fine sandstone and sandpaper, new brushes placed where necessary and the right tension put on all brushes, which secured the trouble.

Some of the brushes on a 150-kw., direct-current generator, which was direct connected to a high-speed engine, sparked badly one night when the load was thrown on the machine. In looking for the cause, also inquiring what was done to the generator while idle, I was told that the brushes were taken off the holders and boiled in oil. When the generator was shut down, I found that, in replacing the brushes, some were placed in the brush holder upside down; this, of course, brought the end of the brush which had the copper coating on it next to the commutator and, as no sandpapering had been done to the brushes, to remove the copper coating, the brushes also did not make good contact on the commutator—they were bound to spark badly.

This was the work of an inexperienced man who, perhaps, thought it made no difference how the brushes were replaced.

Things were made right by placing the brushes as they should be and smoothing up commutation.

I believe there are many electric motors ruined by careless operators who may stop or start a motor. They have the practice of closing the switch, then throwing the lever at the starting box to the fourth or fifth segment at once; this is bad practice, as it allows a heavy current to pass through the motor, thereby placing a heavy strain on the motor. I have seen a large motor, which was connected to a line shaft by a belt, loosened on the foundation, due to this practice of allowing too much current to pass through the motor at once when starting, as it makes the motor start with a jerk.

The proper way to start a motor is, first, to close the controlling switch, then move the starting-box lever so the motor starts off slowly. In this way, no unnecessary strain will be brought on the motor and machinery to which it is connected.

A direct-current stationary motor was about to be brought up to full speed by moving the controller lever, when suddenly the motor slacked up and stopped, with the controller lever in full speed position. At first it was thought that a fuse had blown or the circuit breaker thrown, but this was not the case; then an investigation disclosed the fact that the brush on the controller lever was raised from the segments. On investigating further, it was found that one of the segments became loose and was a little higher than the others, and when the lever was brought over this segment, it raised the brush in such a position in the holder that it did not return to make contact with the next segment which was lower, when there was no current passing to the motor.

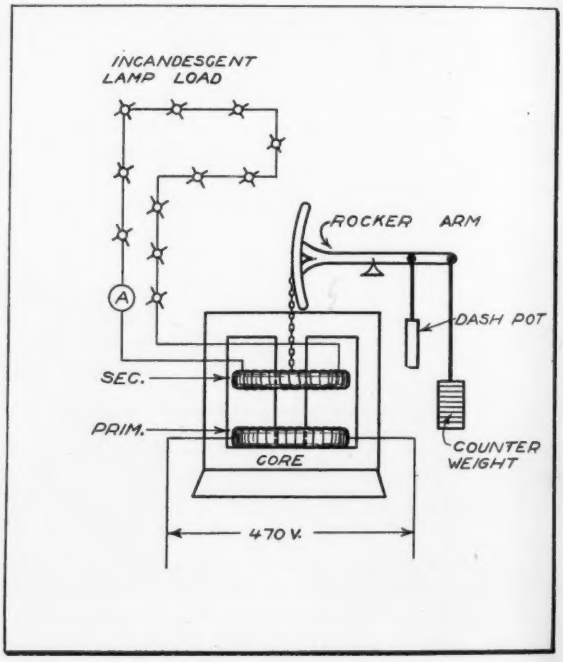
Things were made right again by tightening the loose segment and lowering the controller brush so as to make contact with the segments. H. A. JAHNKE.

Transformer Trouble

THE VOLTAGE impressed upon the primary windings of constant current transformers such as are used in the regulation of current in a series arc lamp circuit, is supposed to be maintained fairly constant, the permissible variation being from 5 to 10 per cent.

An inspector employed by an electrical manufacturing company was recently called upon to find out the cause of the poor regulation of a certain unit, the diagrammatic connections of which are shown in the accompanying figure.

Inspection of the transformer indicated it to be carefully installed and well maintained, but brought out the



CONSTANT CURRENT TRANSFORMER WITH CONNECTED LOAD

fact that the secondary current varied in such a manner as to indicate a swinging short circuit on the line, although no such short circuit existed.

It was found, on investigation, that the primary of the transformer was rated at 470 volts but was being operated at 420 volts, this low voltage being due to the inability of the turbine to maintain its proper speed on account of carrying an overload of about 40 per cent.

It is probable that this erratic operation was in some measure due to the reduced frequency also caused by the drop in turbine speed.

J. A. HORTON.

Observation of Smoke Densities

RESULTS OBTAINED FROM A ROTATING CIRCULAR CHART. BY J. H. DIETZ

IN every city having smoke inspection departments, trained observers are required to determine violations of the smoke ordinance. Most cities allow total production of dense smoke of 6 to 8 min. in any one hour. Dense smoke is variously defined, but is coming to mean number 3 or 4 of the Ringelmann Chart, which means 60 per cent or more of density as determined by these charts.

An improvement on the Ringelmann Chart has been perfected by E. P. Roberts, smoke inspector of the city of Cleveland, Ohio, which consists of a disk having concentric rings as shown in Fig. 1, the outer ring being solid black, the next having 80 per cent black and 20 per cent white spaces alternating, the next ring a ratio of 60 and 40 black to white, the next a ratio of 40 to 60 black to white, and the inner ring a ratio of 20 to 80 black to white. These are numbered, beginning with the inner ring, 1, 2, 3 and 4, corresponding to the same numbers on the Ringelmann Chart.

By rotating this chart, each ring gives a solid color, which may be compared directly to the smoke issuing from any stack, and its percentage of density accurately determined within the limits of its grades. A conscientious observer equipped with one of these charts can make no error in determining violations of an ordinary nature if the quality of the dense smoke is defined in terms by these numbers and percentages.

A careful observation was recently made with this device on a chimney in the city of Cleveland, the observation extending over a period of 10 hr., involving all the variations in the load and conditions of firing. plotted as shown on the attached profile sheets, which include the time from 11 to 1 o'clock, showing the cleaning of fires, beginning at a few minutes of 12 and affecting the production of smoke until a little after 1 o'clock.

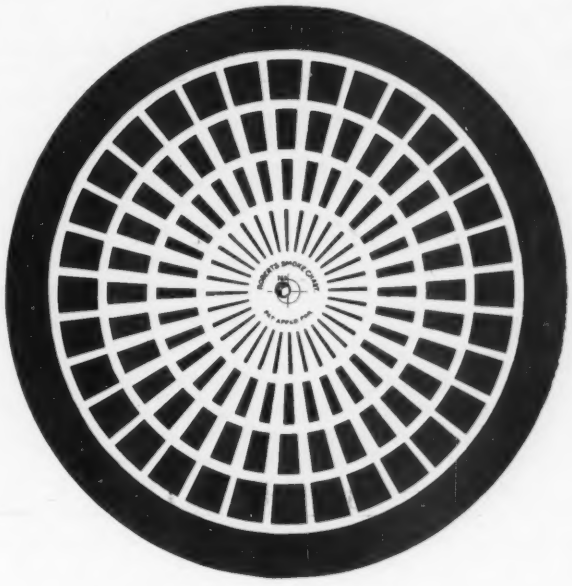


FIG. 1. ROBERTS SMOKE CHART

The results shown are well within the limits of the city smoke ordinance and are interesting from the fact that these were secured on hand fired boilers with Pittsburgh No. 8 coal, equipped with the American Fuel Saving Co.'s Force Draft System.

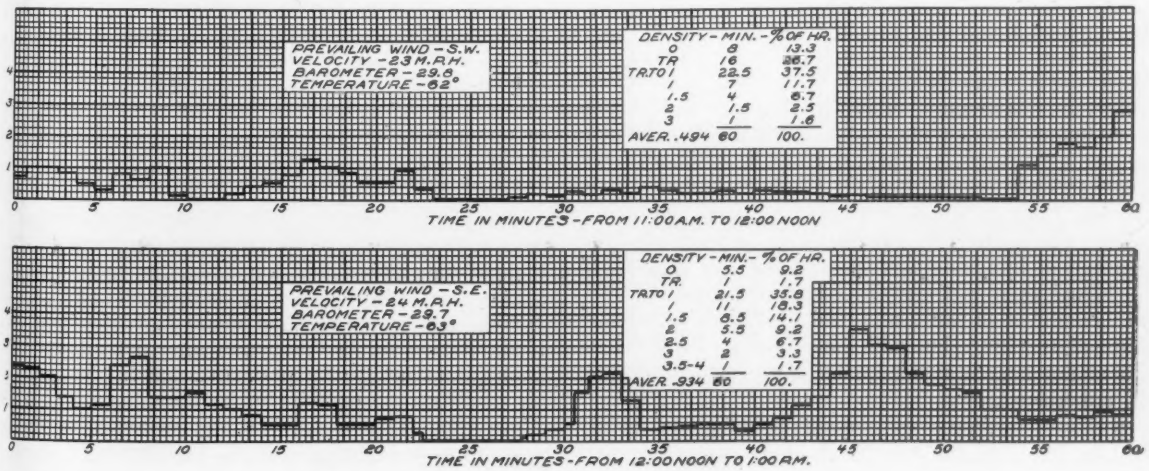

PREVAILING WIND - S.W.
VELOCITY - 23 M.P.H.
BAROMETER - 29.8
TEMPERATURE - 62°
DENSITY - MIN. - % OF HR.
0 8 13.3
TR 16 26.7
TR TO 1 22.5 37.5
1 7 11.7
1.5 4 6.7
2 1.5 2.5
3 1 1.6
AVER. .494 60 100.
TIME IN MINUTES - FROM 11:00 A.M. TO 12:00 NOON
PREVAILING WIND - S.E.
VELOCITY - 24 M.P.H.
BAROMETER - 29.7
TEMPERATURE - 63°
DENSITY - MIN. - % OF HR.
0 5.5 9.2
TR. 1 1.7
TR TO 1 21.5 35.8
1 11 18.3
1.5 8.5 14.1
2 5.5 9.2
2.5 4 6.7
3 2 3.3
3.5-4 1 1.7
AVER. .934 60 100.
TIME IN MINUTES - FROM 12:00 NOON TO 1:00 P.M.

FIG. 2. PLOTTED RESULTS OF SMOKE DENSITIES

The observations were made from 2 different points by independent observers at 15 sec. periods, or 4 times per minute. To make observations of this rapidity required the assistance of a clerk to each observer and the constant rotation of the disk stationed between the observers and the stacks.

This was accomplished by attaching the disk to a small storage battery electric motor. The results were

DRILLING OF wells by the use of a "mud laden fluid," is a late improvement developed by the Bureau of Mines. The fluid consists of about 20 per cent by weight of clay mixed with the water, the kind of clay known as gumbo being suitable. The well is kept filled with this fluid, and the clay is deposited on the surface and in the pores of the strata surrounding the well, thus closing it against the gas or oil pressure.

Gas Engines vs. Steam for Pumping

COMPARISON on a commercial basis between a suction gas producer pumping-engine plant and a steam engine plant operating under similar conditions, is afforded in a paper by J. E. Gibson and S. H. Wright, which was read before the Engineers' Club, of Philadelphia. The gas plant belongs to the Delaware Water Co., and is situated at the head of tidewater on the Christiana Creek.

The plant consists of 2 complete producer units, rated at 110 hp. each, and 2 13 by 12-in., single-acting, 3-cylinder vertical gas engines of 89 b.hp., each direct connected to a 13 by 15-in. single-acting triplex pump. The engines run at 265 r.p.m., and the pumps, through a 5 to 1 reduction gear, at 44 r.p.m., at which speed each has a capacity of 1,640,000 gal. per 24 hr.

The steam pumping plant belongs to the Actoraro Water Co., and is located on the Octoraro Creek, near Quarryville, Pa. It consists of 3 100-hp., return-tubular boilers supplying steam to 2 horizontal, cross-compound condensing Corliss pumping engines, having 18 and 32 by 30-in. steam ends and 10 by 30-in. water ends delivering at a pressure of 150 lb. These engines run at 55 to 60 r.p.m., and are rated at 3,000,000 gal. capacity.

Costs of plants, fixed charges and comparative table of costs of pumping over a series of years are given in the Practical Reference Tables of this issue.

Soldering Aluminum

By C. H. Poland

THE usual process comprises the following: First cleaning the surface of the article where it is to be soldered so that it is perfectly clean from grease and dirt, and then covering with a flux, or soldering fluid as it is sometimes called, but the base of which is almost invariably chloride of zinc. Then a copper soldering iron or a torch is used to flow the ordinary soft solder, which is composed of 50 per cent tin and 50 per cent lead, and known to the trade as "half-and-half" solder. Proceeding along these lines to carry out the operation of soldering aluminum, there can be nothing but failure to reward anyone for his time and trouble, as this metal is so easily corroded that it will not stand a flux of any kind, but will immediately turn black as soon as any heat is applied to it, and of course nothing will adhere to it.

Now, my advice to anyone wishing to solder aluminum is to forget the term "soldering aluminum" entirely, and treat it as a brazing proposition, as that is really what it is.

The first thing to do is to get a special aluminum solder composed of tin 2 lb., spelter 8 oz., aluminum 1 oz., phosphor tin 1 oz.

In making this aluminum solder, put the spelter and aluminum in a crucible and melt, and when melted add the tin and stir well. Then take the crucible from the fire and add the phosphor tin and pour into thin strips. It is then ready for use.

The melting point of this solder is so low that it can be used on sheet aluminum, as well as on any of the alloys of zinc and aluminum. It is one of the best solders for brazing aluminum known.

There are several ways to go about this brazing operation, depending on the character of the piece to mend. Some small work can be held in a vice, while other larger pieces, such as a cracked or broken automobile crankcase, must be done on the floor or bench.

The thing that must be provided for in laying out the job is some way to clamp the broken parts firmly together when the solder begins to flow; otherwise the pieces will not stick together.

To carry out the operation as it is being done daily in one of the large automobile factories, proceed as follows: First, scrape free from dirt the edges or surface of the piece to be brazed, then heat with a torch or blowpipe, holding the stick of solder close to the flame so that some of the solder will be melted onto the edges or surface of each piece to be brazed. This solder will not flow evenly over the surface like ordinary soft solder, but will be in a plastic state, and will cling together in lumps on the surface of the work. Now, while it is hot, take a steel scraper or any kind of a worn-out 3-square file (ground to a point, it makes a very good tool for this work), and scrape thoroughly the edge or surface of each piece. It will then be found on wiping off the excess of solder that a perfectly tinned surface results. Then clamp the pieces to be brazed together and heat them hot enough to flow the brazing solder that you have tinned the edges with, when hot screw up on the clamps until you get a tight joint, and then let cool. When cool, the edges may be ground or filed down to a finish, so that it will be almost impossible to tell where the piece was mended.—Brass World.

Notes on Uniflow Engine Performance

SPEAKING of the performance of the Cooper Uniflow engine in the plant at Port Clinton, Ohio, before the Ohio Society of Mechanical Steam and Electrical Engineers, A. C. Ruhl gave some interesting data. The engine is a simple expansion with cylinder 33 in. in diameter and 36 in. stroke, the piston being 31 in. long and hollow. This gives exhaust opening 5 in. from the end of the forward stroke and closure at 5 in. on the return stroke, the port being 5 in. long. The steam valves are double ported Corliss in the heads, so that the heads are jacketed by the incoming steam, which is at 170 lb. pressure with 30 deg. superheat at the engine, although the design was to use 100 deg. Speed is 125 r.p.m. and pressure at the end of compressions 160 lb. with vacuum 22 in. The rating is 640 hp. at 40 lb. m.e.p.

Tests at ¾ load with 24 in. vacuum have shown a steam consumption of 11¾ lb. per horsepower-hour, which, corrected to 26 in. vacuum and 100 deg. superheat, is estimated to give 10 lb. steam per hp.-hr. Carrying 700 kw. on the generator, the cutoff is at 5 in. and for 640 hp. at 2 in. Clearance figures out 3 per cent at one end and 4 per cent at the other.

Foreign Development in the Power Plant Field

INFLUENCE OF THE TEMPERATURE OF SUPERHEAT ON THE EFFICIENCY OF STEAM ENGINES; EFFICIENCY OF CABLE TRANSMISSION; PROTECTION OF GAS PIPES. BY J. H. BLAKEY

IN a recent issue of the Bulletin de la Societe Industrielle de Mulhouse, M. Kammerer considers this subject. The question can really be studied only experimentally, as it is well established that the economies resulting from superheat differ considerably from that indicated by theory, which, in this case at least, is not to be depended upon. The author has collected a large amount of data from experiments conducted upon engines running at different degrees of superheat, with the same load, the same admission pressure and the same vacuum in the condenser. The engines were single-cylindered, double and triple-expansion, both condensing and noncondensing.

It is difficult to summarize the results of these tests, but one or 2 facts seem to stand out prominently. In the first place, it appears to be well established that a hard and fast rule cannot be laid down which will apply to any group of engines, to explain the variation of the consumption in function of the superheat. Although it is agreed that the influence of the temperature of the steam is greater as the consumption of the engine is higher, M. Kammerer denies that there is any well-determined relation between these factors, as has been claimed by other investigators.

It is found, however, that for the great majority of condensing engines, the consumption is, up to a temperature of about 300 deg. C., nearly a linear function of the temperature; that is to say, that it diminishes in proportion to the elevation of the temperature. This proportion seems to continue even beyond 300 deg. for engines in which the high-pressure cylinder is jacketed, while for those which are not so provided the benefit of the superheat seems to diminish after passing 300 deg., and continues to be very small up to 500 deg., which is practically the limit of superheat attainable. In other words, the advantage gained by raising the temperature of the steam above 300 deg. C. is not sufficient to justify the increased expenditure of fuel.

In the second place, the advantages of superheating are, in general, greater as the engine is less economical. The reasonableness of this will be seen when one considers the utility of the heating of the cylinders by jacketing in engines using superheated steam. The jacketed engine being more economical with saturated steam than one without a jacket, superheat benefits the former less than the latter, which becomes at a certain temperature more economical than the former. It is with small loads that the jacket is an advantage with saturated steam, while its influence is felt less with a longer admission; but it is also with small loads that superheat has more effect upon the consumption of steam in engines without jacket, and decreases it rapidly.

Admit, for example, with a good compound or triple expansion engine, with jacketed high-pressure cylinder, and at temperatures as high as 300 or even 350 deg. C., an average value of, say, 1/50 lb. per deg. for the decrease of consumption due to superheat, which would come near the truth. If the engine under consideration has a very small consumption a lower value may be taken, possibly ¾ of this, or even less if running with very light load. If, on the contrary, the engine is not so good, or is heavily loaded, this quantity may be increased by 50 per cent. If the high-pressure cylinder is not jacketed, higher values still may be taken for small amounts of superheat and early cutoff, and smaller values for temperatures above 300 deg.

As to single-cylinder engines, the number of tests made by M. Kammerer were not sufficient to enable him to deduce any definite rules. It is, nevertheless, pretty well established that these engines are benefited less by superheat than those in which the steam is expanded a number of times.

Noncondensing engines, whether having 1 or 2 expansions, are greatly benefited by superheat, although the absence of the condenser would lead one to expect that the loss by initial cooling would be less than in condensing engines. But here, again, the number of tests made was insufficient to justify any positive rule. At low temperatures, one degree was found to decrease consumption by about 1/25 lb., and sometimes more, while with high superheat, that is above 350 deg. C., it seems that not more than 1/50 lb. is to be expected.

If, instead of considering the resulting economy in pounds (which, however, is generally quite satisfactory, and is often the most suitable way of checking the manufacturers' guarantee in a test), it is desired to convert the economy into thermodynamic efficiency, it may be taken as a rule that for a good double-expansion engine, the thermodynamic efficiency increases by about one unit for every 25 deg. of superheat, and this will be found to be nearly true for all temperatures, if allowance is made for what has been said about temperatures above 350 deg. C. For single-cylinder and noncondensing engines the effect is sensibly greater, and may be put at one unit for every 10 deg. or even higher.

EFFICIENCY OF CABLE TRANSMISSION

ZEITSCHRIFT des Vereines deut. Ing. gives the results of experiments made to determine the efficiency of rope transmissions, and especially to discover whether this method of power transmission is as wasteful as has recently been stated by Professor Kammerer. The test-

Load	3 cables at 50 80 110 ft. per second	2 cables at 50 80 110 ft. per second	1 cable at 50 80 110 ft. per second
113	94.1 95.2 94.5	94.5 93.5 93.6	92.1 95.5 93.9
142	94.8 95.2 95.5	94.5 93.5 95.4	92.1 95.5 93.9
170	95.3 97.6 95.5	96.7 95.9 95.4	95.0 96.6 95.5
213	95.3 97.7 95.5	96.7 96.4 96.6	95.0 96.6 97.1
284	97.2 97.7 95.5	96.7 96.4 96.6	95.0 96.6 97.1
320	97.2 97.7 95.5	96.7 97.3 96.6	95.0 96.6 97.1
355	98.2 97.7 95.5	98.4 97.3 96.6	96.8 98.3 97.1
455	98.2 97.7 95.5	98.4 97.3 96.6	96.8 98.3 98.3
532	98.2 97.7 95.5	99.0 97.3 96.6	96.8 98.3 98.3
640	98.2 97.7 95.5	99.0 97.3 96.6	96.8 99.0 98.3
1065	98.2 97.7 95.5	99.0 97.3 96.6	97.9 99.0 98.3

ing appliance consisted of a 200-hp., 3-phase motor, coupled to a shaft carrying 3 grooved pulleys of different diameters, by means of which tests were made at speeds of 50, 80 and 115 ft. per sec. The transmission pulleys, on ball bearings, were each 10 ft. in diameter and were grooved at an angle of 45 deg. The shaft of each carried a prony brake pulley.

In the table, the load is in pounds per square inch of section of cable, velocities are in feet per second and efficiencies are in per cent.

At the same time the loss of speed was determined, as follows:

Load.....	213 lb.	355 lb.	532 lb.	1065 lb.
Loss.....	.15%	.25%	.40%	1.00%

Protection of Gas Pipes Against Electrolysis

A French journal describes a method of protecting gas pipes against electrolysis, which has been found very satisfactory. It consists in making an insulating joint between the lengths of pipes by means of a wooden ring and a washer of rubber. Untarred jute is then hammered into the joint, and the whole is covered with an insulating material of the nature of wax. No lead is used. The joints made in this way are quite costly; but as the rubber is perfectly protected from change of temperature and the moisture of the earth, it is believed that they will last a long time. Experiments have shown that there is absolutely no electrolytic action going on in the pipes, although they lie parallel with and close to a line of electric railway.

Steam Condensers for the Ice Plant*

Care and Operation of Skimmers and Reboilers, Coolers, Filters and Storage Tanks. By A. G. Solomon

DISTILLED water is carried from the condenser to the skimmer where the oil that it still contains will come to the surface and be skimmed off at regular intervals by letting the water rise high enough so that the top part will overflow into a funnel-like arrangement which is piped to the sewer.

In some plants, one tank is used as skimmer and reboiler combined, while in others 2 separate tanks are used. It is good practice to have the overflow from the skimmer pipe in such a way that it is in plain view of the man who is pulling ice and filling the cans. He can then regulate his can filling so that the overflow will occur at the intervals that are determined by the amount of oil that appears on the top of the water in the skimmer.

Water in the reboiler is kept at the boiling point so that all gas and air are eliminated. Generally, a closed coil is used and the condensation returned to the skimming tank or to the condenser.

By regulating the temperature with a valve on the outlet instead of the inlet of the coil, more heat is given up for the amount of steam used. And in this way, the condensation can be allowed to flow directly back into the reboiler. Do not boil the water violently, as it is not at all necessary and is only a considerable waste of steam.

The water must never be allowed to get so low that air is admitted to the flat cooler coils or the ice will have a cloudy appearance. The water is generally kept at its proper level by means of a float and lever valve which is set to close the outlet when the water has reached its lowest point.

Pipe work must be air-tight in all lines which take the water from the reboiler to the ice cans. Also the packing of all valve stems must be kept tight or air will be drawn in. For example, if the packing on the valve stem of the valve directly under the reboiler is leaking, air will most surely be drawn in when the float closes the valve.

There must be a valve between the reboiler and the float valve, so that the latter can be repaired or packed without losing all the water. The object of the reboiler is to get rid of all remaining gas and air that is not thrown out by the steam condenser, so care must be taken not to let more air get in.

As a general rule, the reboiler is placed just beneath the steam condenser and close to it, but sometimes it is above or on the roof. This latter case is especially true in such plants as use the double pipe or the surface condenser which are placed in the engine room.

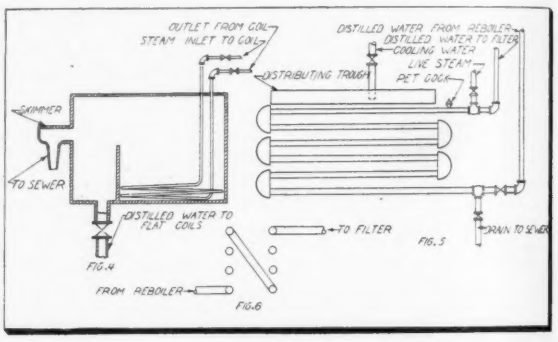


FIG. 4. SHALLOW REBOILER WITH FLAT COIL
FIG. 5. SINGLE FLAT COIL
FIG. 6. CONNECTION FOR 2 FLAT COILS IN SERIES

If the reboiler is above the condenser, the distilled water is collected in a tank and pumped to the reboiler. The pump is provided with a float valve, so that the collecting tank is not pumped dry and the oil which is at the top also put into the reboiler. The collecting tank acts as a skimmer.

In the case of pumping the distilled water, a lot of heat is lost and this will make it necessary to use more steam in the reboiling.

Sometimes when steam pressure gets low, I have seen the steam shut off the reboiler to save that much. This is an entirely wrong practice, for the ice will surely show discolored. Do not shut the reboiler off unless you also stop filling cans, or drawing any water out of the reboiler while the reboiling has been discontinued.

*Continued from page 640 June 15 issue.

The most common type of reboiler is a round tank, about 3 ft. in diameter by 4 ft. high, and made of heavy galvanized iron. A circular coil is at the bottom. The other kind, which is quite a favorite, is rectangular in shape, about 3 ft. wide, 8 or 10 ft. long, and only 12 to 18 in. deep. The coil is made up of pipe full length of the tank, and put together with return bends. The distilled water enters at one end of the tank and flows to the other end before the outlet is reached. This long travel and large, exposed surface is very efficient in expelling gas and air. The skimming is provided for by a partition at the outlet end over which the oil flows at regular intervals which are generally controlled by an automatic arrangement which can be adjusted to suit the operator.

Flat Cooler

Next, the distilled and reboiled water is cooled by passing through a set of coils commonly called the flat cooler. These coils are generally of the single-pipe atmospheric type, with the cooling water flowing over the outside.

Sometimes the double pipe arrangement is used, but it is hard to steam out the oil which collects between the inner and the outer pipe; and heating up this latter type often causes leakage in the gaskets, owing to the unequal expansion of the different pipes.

The benefit of the counter-current, water-cooling effect is taken full advantage of in the flat coolers, whether the single or double-pipe coils are used. The distilled water from the reboiler enters the bottom pipe, passes upward through the coil and is discharged at the top. The coldest water available should be used, as every heat unit taken up by the cooling water is so much less that it has to be extracted by the ice machine. Keep the cooling surfaces clean as possible by constant attention. Only a few of the bottom pipes will have scale formation; but if this is not cleaned often, the scale will continue to form on more coils till the efficiency of the cooler is greatly reduced.

These coolers are sometimes built in series of 2 coils, the water entering the bottom of the first and again entering the bottom of the second from the top of the first. The fullest cooling effect of the water is thus obtained, but the friction is also increased and the water might travel too slowly unless the reboiler is quite high.

The habit of steaming out the flat coils is greatly overdone by a large number of engineers. Oil will collect in these coils and stick to the inner surface, owing to the cooling of the water. Each coil is provided with suitable valves for shutting off separately and also with a drain at the bottom and a pet cock at the top for letting out the air when filling.

Each coil is connected to a live steam line for steaming. The coils are emptied and steam allowed to enter at the top, and by heating, all the oil is loosened and supposedly blown out. Then the coil is again filled and opened for service. A lot of oil which has become loosened, but not discharged, will now travel with the water and the filters will have to take care of it. This is one way that the filters become filthy and worse than useless.

Some plants insist on steaming out those coils twice every 24 hr. In practice, I have found that this is unnecessary and usually does more harm than good. The distilled water they contain is wasted and the steam required amounts to a great deal. Once a week, or perhaps even less, is enough to steam the coils. I would advise those who have been in the habit of the daily steaming, to try letting it go for a few days, watch results carefully and see if less often will not answer just as well.

When they are steamed, be sure to let the water circulate through them and to the sewer long enough to carry off all loose oil. Before filling, turn on the cooling water and get the coils nice and cold; this will cause some of the oil particles to stick to the pipe, where they will cause no trouble.

Do not attempt to save the distilled water you blow out, for it contains oil and if allowed to get into the reservoir or any place except the sewer, it will be sure to find its way into the boiler, where it will cause lots of trouble and extra work and expense to get rid of it.

Another cause of bad ice can be traced to the cooling water's being allowed to stop flowing over the flat cooler for even a few minutes. If the water stops, the

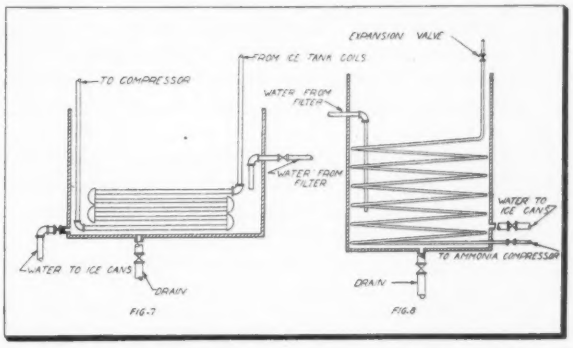


FIG. 7. STORAGE TANK WITH COILS ON SUCTION FROM ICE TANKS TO COMPRESSOR

FIG. 8. STORAGE TANK WITH DIRECT EXPANSION COIL

hot water from the reboiler will immediately loosen the oil and send it into the filters, and if the cooling water is not quickly started flowing, the filters will become warm and the oil in them will go with the water into the storage tank and then into the ice cans.

Filters

Now that the distilled water is free from air and gas, and cooled, it goes to the charcoal filters, where the remaining impurities are taken out and the charcoal also acts as a deodorizer and purifier. The filters are made of sheet steel and are well riveted and as a rule in common practice they are about 3 ft. in diameter and 6 ft. high. They are provided with a false head about 6 in. from the outside top and bottom heads. This false head is perforated and is used to keep the charcoal in place. Then the entire space is filled with charcoal of a grade made especially for this purpose.

In some plants, a hot water filter is used, through which the distilled water passes before going through the flat coils. Quartz is used generally, and a lot of oil is caught, but the filter gets dirty quickly and requires steaming and washing nearly every day.

The charge of charcoal in the cold filters will have to be removed and washed at least once a year. The

frequency of washing or renewing will depend on the care of the other parts of the distilled water system and the kind of cylinder oil used.

The water can enter the filters either top or bottom, as both have certain advantages.

When the water enters at the bottom, the oil and impurities can be blown out with steam which is admitted to the top through a steam line provided for that purpose. The steam should be left to blow till the condensation coming out of the drain valves shows free from oil.

Do not, as I once had the misfortune to do, rip the filter from one end to the other. In that case, I had cut out a charcoal filter for steaming it out. I emptied out all the water and opened the 1-in. steam valve about a turn, to warm up the charcoal and get the heavy oil out that I knew was in the bottom.

The oil and dirt began coming out, as it had always been in the habit of doing, and I went to some other part of the plant to attend to something else, and left the steam turned on.

It generally took at least an hour to do a good job of steaming the filter; but this time, about 15 min. after I had turned on the steam, there was a loud report, and the filter was a thing of the past. The drain must have become blocked and the full boiler pressure of 125 lb. had pulled all the rivets through the galvanized-iron sheet.

This same accident might happen in any place, and I have come to the conclusion that a pop safety valve and pressure gage have a perfect and proper right to be on all filters that are to be steamed out. Since my blow-up, I have heard of a cast-iron filter blowing up and doing serious damage. Be on the safe side, and invest in a pop valve.

After steaming for a sufficient length of time, the water should be turned on again and the air allowed to escape at the pet cock, which is on top of the filter. Do not fill the freshly steamed filter quickly, but let the water in very slowly, so as to cool the charcoal and not carry any oil particles up through.

When the distilled water is admitted at the top, it only makes matters worse to attempt steaming, as it will drive the oil down into the charcoal, but never all the way through. The proper way to clean a filter using the top inlet, is to have cross connections so that the flow of water can be reversed.

Have a gate valve at least 1¼ in. at the top of the filter and, after shutting off the inlet and outlet valves, open the valve that will admit the water to the bottom. Then open the 1¼-in. gate valve on top and the oil will be floated out. The valve admitting the water at the bottom should only be opened a little way. This way of cleaning should be used for about 10 min. once a week, and the oil will never get time to penetrate any distance into the charcoal.

Some filters are connected in series in the same manner as the flat coils, but I do not believe there is anything gained by so doing. If the water is not cleaned sufficiently after passing through 5 or 6 ft. of charcoal, there must be something wrong, and it should be investigated.

Sponge filters are sometimes used in the water line before the water goes to the can filler. This is a good plan to catch any particles of oil, for the water at this point should be about 40 or 45 deg., and the oil will readily separate and stay in the sponges.

The sponges must be changed at least once a day and the dirty ones washed with lye in boiling water and then in clear hot water. This filter need not be large and is easily made of a piece of 6-in. pipe about 12 or 15 in. long. When sponges are changed, care must be taken to let the air all out, or a few blocks of ice will be cloudy or filled with air needles.

There are several filters on the market which are used in the place of those home-made sponge filters. They are cheap, convenient and can be cleaned in 1 or 2 min. One style uses cloth and pressed cotton fiber for the filtering material, and it is almost impossible for any impurities, no matter how fine, to pass through. The cloth can be washed when dirty, but the fiber disks are thrown away. This style of filters is opened up without the use of any tools or gaskets, as they are fastened entirely with bolt hinges having nuts with handles on, same as thumbscrews, only larger.

All filters should be provided with suitable pipe connections and valves so that they can be cut out of service for cleaning and repairing without stopping the operation of the plant.

Storage Tank

After leaving the charcoal filters, the now pure, distilled water goes to the storage tank in which it is cooled to a temperature of from 40 to 45 deg. This cooling is done in either of 2 ways, which depend a great deal on the style of ammonia compressor used. With a vertical, single-acting, dry-gas machine, it is customary to cool the storage tank water by means of the gas returning from the ice coils. The coils in the storage tank are connected to the suction of the ammonia compressor by means of manifold headers. The frost is never allowed to extend through the coil so as to appear on the suction line between the storage tank and the compressor.

The other arrangement, generally used with wet compression machines, is to have direct expansion coils in the tank and these are fed by an independent expansion valve. The coils in either case must be kept entirely submerged at all times, or frost will form, and air and impurities will be deposited in the water when the frost melts. These storage tanks are generally made of galvanized sheet steel, and should be well insulated and have a tight fitting top which can be removed without tearing up. They are made large enough so that the water passes through slowly and has a fair chance to cool. The water is admitted at the top and the pipe extends down far enough so that it will always be submerged or air will be taken in if any splashing is allowed to occur. The outlet to the can fillers is close to the bottom. A drain valve is placed in the bottom so that the tank can be emptied when desired.

Either a glass water gage or a float must be used to indicate the water level, and the ice pullers must keep their eyes on this. There is no sense in filling cans fast for a while and then having to wait for the storage tank to catch up. A run-around line should be installed around the tank, so that if anything happens to the tank, the plant can go right along without using it.

Pop Safety Valve Formulas

VARYING RESULTS FROM DIFFERENT RULES; VALVE LIFTS; TEST OF VALVES ON LOCOMOTIVE. BY M. W. LINK*

DURING the last few years there has been considerable agitation toward a uniform "rating" of pop safety valves. This has been caused: First, by the rules now in force in the different communities; second, by variations in the relieving capacities of different makes of valves, all having the same diameter of seat opening.

BOILER RULES AND FORMULAS

A FEW of the existing rules are as follows:

1. One square inch of pop valve area for every 3 sq. ft. of boiler grate surface—Chicago and others.

2. $A = \frac{22.5 \times G}{B P - 8.62}$ Philadelphia.

3. $AA = \frac{WS \times 70 \times 11}{P}$ Massachusetts.

4. $A = \frac{0.2074 \times WH}{P}$ U. S. Supervising Inspectors.

5. $D = \frac{0.036 \times H}{L \times P}$ American Railway Master Mechanics.

6. $D = \frac{0.0095 \times E}{L \times P}$ Proposed to the American Society [Mechanical Engineers.

In the above formulas—

A = Area of pop valves in square inches.

AA = Area of pop valves in square inches per square foot of grate surface.

WH = Pounds of water evaporated by boiler per hour.

WS = Pounds of water evaporated per square foot of grate surface per second.

P = Boiler pressure (absolute).

BP = Boiler pressure (gage).

D = Diameter of seat of pop valve with 45 deg. seat, inches.

L = Lift of pop valve, inches.

H = Heating surface of boiler, square feet.

E = Evaporating capacity of boiler, pounds of steam per hour.

G = Grate area in square feet.

The last 2 formulas (5 and 6) are the latest to be advanced in the United States.

They are the result of a thorough study by their endorsers and show the tendency of the times, by recognizing the fact that all pop valves of a given size do not have the same relieving capacity.

Formula 5 is for pop valves to be used on locomotives and has the indorsement of the American Railway Master Mechanics Association. Locomotives equipped with pop valves figured to this formula should have no difficulty in passing the "over-pressure" tests laid down by the Interstate Commerce Commission Engineers.

*Of the Mechanical Expert's Department, Crane Co.

Formula 6 is the one that takes into consideration 3 extremely important features which enter into the successful installation of pop valves on boilers:

1. Evaporating capacity of boilers.
2. Lift of pop valves.
3. Diameter of the seat bore of pop valves.

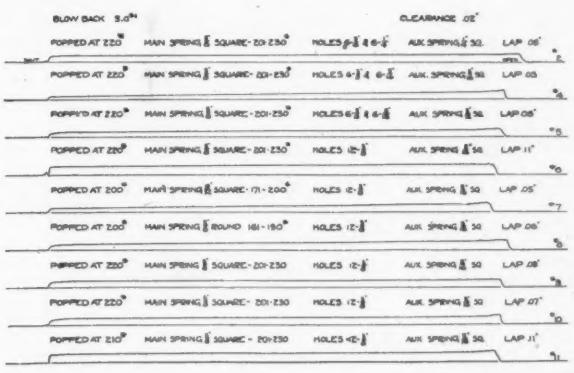
The constant 0.0095 was derived after a series of tests made at the plants of a large boiler manufacturer and a large railroad, for 45 deg. seat pop valves. Flat seats have a different constant.

APPLYING THE RULES

NOW LET us try out the above rules or formulas, and see what varying results are obtained.

Assume the boiler to be equipped with pop valves to have the following rating:

40 sq. ft. of grate surface.
1200 sq. ft. heating surface.
8000 lb. of water evaporated per hour.
175 lb. absolute boiler pressure.



LIFT CHART OF A 3-IN. CRANE LOCOMOTIVE POP SAFETY VALVE

Using the various rules, this boiler would have, respectively, the following size pop valves, the lifts and discharge being explained later on:

Rule 1. 1—4½-in. pop valve.
Rule 2. 1—3 -in. pop valve.
Rule 3. 1—3½-in. pop valve.
Rule 4. 1—3½-in. pop valve.
Rule 5. 1—3 -in. pop valve with .09-in. lift, 1—2-in. with .15-in. lift and 2—4½-in. with .03-in.
Rule 6. 2—2½-in. pop valves with .09-in. lift, 1—3-in. with .15-in. lift and 3—5-in. with .03-in.

Further comment should be unnecessary, except that at a test made by the writer upon a locomotive, having 4020 sq. ft. of heating surface and 53.7 sq. ft. of grate surface, operating under 220 lb. working pressure, in which there were 3—3-in. pop valves used; it was impossible to increase the pressure over 220 lb. with 2 of the pops blowing. In this test the locomotive was stationary, the 1¼-in. blower valve was wide open,

no water was admitted to the boiler during the test, and the hottest possible fire was maintained. In this test it was impossible to make the third valve pop, as the valves were set for 220, 222 and 225 lb., with a 4-lb. blowback.

Lifts of Pop Safety Valves

We have made an exhaustive study of pop safety valves of all types, sizes and makes. A few of the lifts are given below:

Sample	Size, in.		Popping Pressure	Closing Pressure	Opening Lift, in.
1	4	Sta.	115 lb.	111 lb.	0.03
2	4	Sta.	118 lb.	114 lb.	0.06
3	4	Sta.	150 lb.	146 lb.	0.06
4	4	Sta.	100 lb.	96 lb.	0.13
5	4	Sta.	116 lb.	112 lb.	0.17
6	4	Sta.	150 lb.	146 lb.	0.16
6	4	Sta.	105 lb.	101 lb.	0.17
6	4	Sta.	130 lb.	126 lb.	0.18
7	3	Loco.	200 lb.	196 lb.	0.015
8	3	Loco.	200 lb.	196 lb.	0.05
9	3	Loco.	200 lb.	196 lb.	0.055
10	3	Loco.	200 lb.	196 lb.	0.07
11	3	Loco.	200 lb.	196 lb.	0.11
12	3	Loco.	200 lb.	196 lb.	0.12
13	3	Loco.	220 lb.	216 lb.	0.15
14	2½	Sta.	200 lb.	196 lb.	0.09
14	2½	Sta.	155 lb.	151 lb.	0.10
14	2½	Sta.	85 lb.	81 lb.	0.125
15	2½	Loco.	100 lb.	96 lb.	0.115
16	2	Sta.	100 lb.	96 lb.	0.05
17	1	Sta.	100 lb.	96 lb.	0.05
18	1	Sta.	100 lb.	96 lb.	0.06

From the above table let us select the 4-in. stationary valves. Eight results were obtained. Applying Napier's rule for the flow of steam through an orifice, the discharging capacity through a 45 deg. seat pop valve would be $707 \times 3.1416 \times$ seat diameter $\times$ lift $\times$ pressure, divided by 70. According to the results of this formula, the valve capacity would be rated too high for actual tests.

Steam when flowing through a pop valve flows first to the huddling chamber and then to the atmosphere. This action, while almost instantaneous, retards the flow of steam so that we must resort to actual tests or abide by capacity tests to determine the actual capacity of the valve.

In a paper presented by P. G. Darling before the American Society of Mechanical Engineers in February, 1909, he gave a constant to be used in determining the flow. This gave a tentative formula of $105 \times P \times L \times D =$ capacity, pounds per hour for valves with 45 deg. seat, and a constant of 149, in the same formula for flat seat valves, in which P, L and D, are the same as described above.

Assuming that the variation in the construction of the huddling chambers in pop valves does not affect the flow, the following results would be obtained on 4-in. pop valves with 45 deg. valve seats.

The capacities given are not actual, as the pop valve lifts used in the above table are the maximum, whereas in practice any pop valve opens quickly to its maximum and then starts to close gradually until it approaches the actual closing point when it closes with a snap. (See chart, page 737.) The average lift between the opening and closing point could be used, but it would not be correct, as the time between the popping of the valve and its closing is determined by the volume of steam being generated and consumed.

Sample No.	Popped At	Opening Lift	Relieving Capacity
1	115 lb.	.03 in.	1640 lb. per hr.
2	118 lb.	.06 in.	3350 lb. per hr.
3	150 lb.	.06 in.	4200 lb. per hr.
4	100 lb.	.13 in.	6290 lb. per hr.
5	116 lb.	.17 in.	9300 lb. per hr.
6	150 lb.	.16 in.	11100 lb. per hr.
6	105 lb.	.17 in.	8600 lb. per hr.
6	130 lb.	.18 in.	10900 lb. per hr.

Another important feature in the capacity of a pop valve is its blowback; i. e., the difference between the popping and closing pressure of the valve. Almost any of the valves which we tested could be adjusted to give an increased lift of 0.02 in. to 0.05 in. with a corresponding increase in blowback. One sample was set to give a blowback of 10 lb. and registered 0.22 in. lift. In another case a 3-in. locomotive pop, ordinarily giving 10-in. lift with 3-lb. blowback, was reset and registered 0.25-in. lift with 20-lb. blowback.

Of course, it is perfectly obvious that too high a rate of discharge is dangerous to the boiler, but a valve properly figured for the boiler will prevent any over-pressure, and give long life to the pop. Too high a blowback is wasteful.—The Valve World.

The Value of Old Oil

Undoubtedly many operating engineers are of the firm belief that when lubricating oils have been used for some time, they are of little or no value. They frequently speak of oil "wearing out" and state that after it has been used for some time it should be thrown away and new oil substituted. A series of experiments was recently conducted to determine the worth of used oils.

Results of the tests showed that the purified oil from the filter has a slightly higher coefficient of friction at light loads, and slightly lower at heavy loads than the new oil. Similarly, the temperature, in which the operating engineer will no doubt be particularly interested, was practically the same for both oils, the difference between the two in no instance amounting to more than 2 deg.

The question of physical change in the oil that had been in use, naturally arose. Tests showed that the flash point remained constant at 410 deg. F.; the burning point decreased from 460 to 440 deg.; the specific gravity increased from 0.895 for new oil to 0.903 for the used oil. This rise in specific gravity was to be expected as some of the more volatile constituents were doubtless driven off when passing through the bearings. The viscosity test showed a higher viscosity for the old oil than the new, indicating that the oil gains in body as it is used over and over again, provided the filter thoroughly removes the entrained water. The general conclusions drawn from the test are that the used oil is as good a lubricant as the new oil.

LETTERS DIRECT FROM THE PLANT

Cash Paid For Ideas Accepted. Sketches Desirable.
We Make The Drawings

Trouble with Simplex Steam Pump

THE SIMPLEX steam pump seems such a simple piece of mechanism, that one would think the average engineer, holding a first, second or even third class Massachusetts license would understand all about it; but such is not the case, as the engineers, or at least a good many of them in this locality, are extremely ignorant in regard to what takes place in the steam chest of the steam pump.

One of the reasons for this is that, although our State Inspector has a duplex pump, and every man who passes through his office on his way from the boiler to the engine room is compelled to pull apart, reassemble and be familiar with the setting of the valves, the simplex pump might not be in existence as far as any reference is made or questions asked in regard to it by the Inspector or Board of Inspectors.

The action of all simplex steam pumps is much alike, depending on the make; the main piston or its

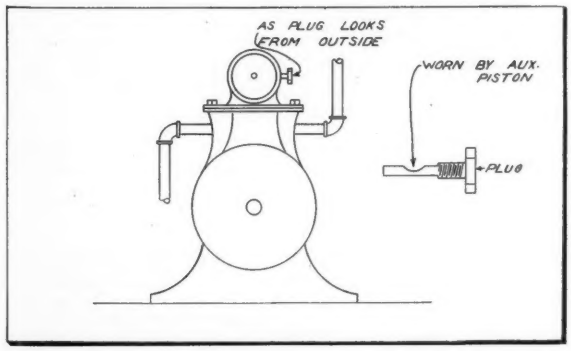


FIG. 1. WORN PLUG AND LOCATION IN PUMP

rod works a tappet that moves a valve uncovering ports, which let steam to one end and exhaust from the other end of an auxiliary piston, forcing this piston from one end of its chamber to the other, carrying the main valve with it, thus admitting steam to one end of the main cylinder and exhausting it from the other. This is what has to be done and done quickly.

In the place where I am employed, there is a condenser pump 10 by 14 by 18, made by Deane of Holyoke, of the vintage of 1887. It has run 24 hr. a day, 6 days a week, since it was installed, and in that time the size of the plant has been increased from a 16 by 36 to a 16-30 by 42, then to a 20-36 by 42; the last 2 were cross compounds, and the only change made in the pump was a larger condensing chamber.

It always worked well and gave us a 26-in. vacuum. I knew little about the action in the steam end, and I suppose I should never have troubled to learn any more about it if we had had no trouble.

This is what occurred. The business was increasing and during the peak load, the engine needed the 26 in. of vacuum, so if anything happened to the pump it was a case of shut-down. At this time, the company divided the work into 8-hr. shifts and we got another engineer. This man was a good engineer, only he had an idea that a pump did not need oil; when the lubricator became empty, he would let it remain so until he was relieved, then the incoming man would fill it and run it about out during his 8 hr., and the next man would do the same, with the result that the pump would run dry during the new man's 8 hr. After a few weeks of this treatment trouble naturally developed. First, we noticed that one stroke was faster than the other, then

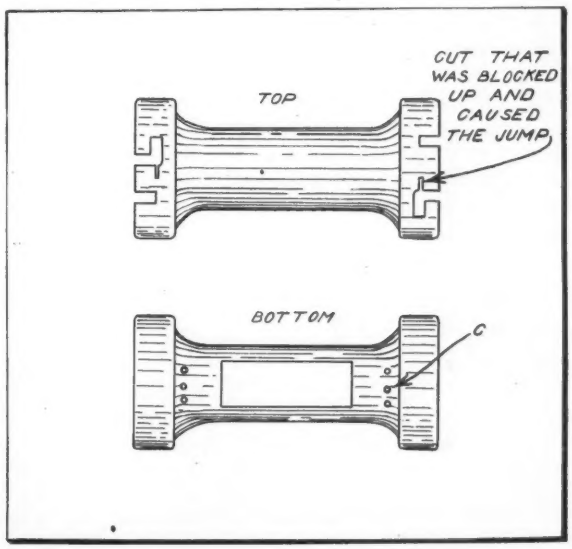


FIG. 2. AUXILIARY PISTON OF SIMPLEX PUMP

it would short stroke and, if the valve rod gland was not tightened up, it would lose vacuum. Then it got so that it would stop at the end of the fast stroke and we would have to pound on the valve rod to make it start; it looked as if it would not reverse, and the steam piston would strike the head and stop. This got so bad that, if one turned his back, the pump would stop and the shock of starting while the vacuum was going back was so great that it soon shook the water piston off the rod and the wear on the valves and springs was excessive.

We thought the suction pipe was blocked, but found it all right; then, after watching the exhaust, we thought steam was leaking past the piston rings. We put in a new set of rings, then a new valve rod, still it kept growing worse; so I invited my engineering friends in to see the pump work and, in my ignorance, acted on all their suggestions.

One told me to put a spring on the valve rod. This did no good. Another suggested that I extend the valve stem through the back head, putting on a stuffing box, as it was in the front, so as to balance the valve. He claimed the area of the valve stem on one end would unbalance it, and I believed him, got a head the same as the front one, bored a hole in the end of valve rod, tapped it and screwed in a piece to extend through the head. The only thing that happened was that I now had 2 stuffing box glands to tighten up on the rod, and I made it so tight that it would take the blow of a sledge hammer to move it. This, of course, was bad for the valve gear and tappets.

I then resolved to stop consulting my friends and get busy myself. I took the top off the valve chamber, tried both valves for tightness and found they were all right, then took the heads off the auxiliary piston chamber and tried to remove the piston, but found I could not without removing the plug at A, which I found pretty well worn, as shown in the sketch. This plug is to prevent the auxiliary piston from turning around too much and the recess worn in it allowed the piston to turn enough to cover its own ports, thus causing the pump to come to a standstill. I found the little cut at B blocked up and cleaned it out with a hacksaw blade. This corresponds with the 3 little ports at C and is to keep the auxiliary piston the same temperature at both ends and to prevent binding; it is also a cushion.

I made a new plug and, after assembly, the pump worked as well as it ever did; but my faith in my engineering friends' knowledge as regards a simplex steam pump received a severe shock.

JOHN H. ARMSTRONG.

Wrecked Engine; Low Crosshead Key

A HIGH-SPEED cross compound engine in a central power station would always have a loose crosshead key after 2 days' run and required constant keying up, after which there was a dull but hard pound for some time, the noise becoming less and the blows lighter after the engine had run a while. This continued for several months without the cause of the trouble being found. One night, the strap parted and wrecked the whole engine.

The engine, 500-hp. with a heavy flywheel, was direct-connected to a 400-kw. d.c. generator. The cranks were 180 deg. apart and the connecting rods short and thick. When the strap let go at the slot, Fig. 1, the end of the connecting rod dropped down between the guides, the end came up against the partition in the frame casting just below the guides and the energy in the flywheel was all that was needed to aid the connecting rod to push the obstruction out of the way, making the crack in the base as at E, but on the other side damaging the frame beyond repair. The guide bolts at the back were broken off flush at the bottom; the stuffing box broken and the inner head cracked. The cylinder head was knocked off and a piece of the flange and cylinder with it. It was a complete wreck, though in general appearance the engine, from a few feet distant, did not show it except for the piston hanging out of the cylinder.

The key was badly battered on the bottom end at A, as was the partition; but the only theory acceptable to all parties was that the strap had let go, causing the wreck. The writer had to accept this theory with the others, not knowing of a better cause. But a few years later, an experience with another high-speed engine served to show why the strap had let go as illustrated in Fig. 1. The engine seemed to be loose on the crosshead pin, and as I was just relieving my predecessor, I made inquiry.

"I always run it a little loose," he replied, "or it will pound and the key work loose."

The next day I keyed up the engine. It pounded and the key worked loose. The engine wreck described flashed to mind and the engine was stopped. On keying up, that morning, I noticed the key was well down and needed to be raised, but time was too limited. I raised the key slightly, leaving the box loose as before, and started up. The pound was gone. I had the clue and after shutting down at night found the key had been striking on the partition piece of the base, below the

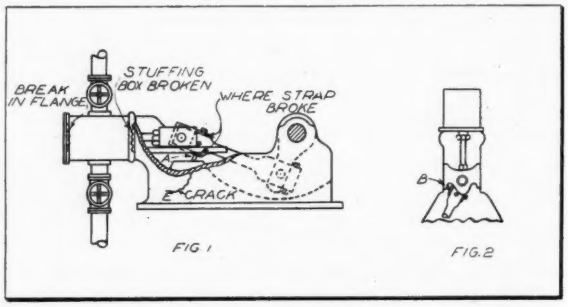


FIG. 1. SHOWING WHERE STRAP LET GO AND LOCATION OF CRACK IN ENGINE FRAME

FIG. 2. KEY STRIKING CROSSHEAD SHOE ON VERTICAL ENGINE

guide, each time it reached the head end. The end of the key was so badly battered that it was removed with great difficulty. A shim was put in under the strap and one between the brass and end of the rod, thus raising the key. There was no more pound while the engine was running.

In Fig. 2 is an illustration of the same character, on a vertical fan engine. The key had been driven through until it struck against the edge of the crosshead and would pound badly.

"It has always pounded," was the reply the engineer received to queries.

It did not take long to block up the crosshead, remove the wristpin, true up the brasses and put in a couple of shims, thus removing the pound. The eccentric rod was also in bad shape and was shimmed up. The pin had to be filed down 1/32 in. on one side to put it into shape.

Since the first experience, I have always taken special care to find the amount of clearance beneath the crosshead and rod end keys on all high-speed engines; also, the amount of clearance between the strap and crosshead on all Corliss and fan or other engines. In some cases, I have found only 3/16 in. between the rod end and the edge of the crosshead on some quite large engines. This is sufficient but should be known by the engineer in order to avoid trouble or accident when making adjustments on the rod ends, brasses and keys.

R. A. CULTRA.

Getting A Training

AS TO the best course to become an engineer, I believe the adage, "Practice makes perfect," and in engineering one can get only a certain amount of practice in one plant, as the same conditions continue to repeat themselves; when a man can fully overcome these conditions, he is about done learning through practice in that plant, but by having a good library of engineering books by reliable authors, coupled with his practice, he can become proficient in his calling. If I had a boy growing up who wanted to learn steam engineering, I should first give him a common school education and put him to work in a machine shop where engines were built, and at the same time have him attend night school and study mathematics, which I find to be indispensable.

After serving time enough to be a first class machinist and understand engine construction, I would advise him to take a position as an assistant in some large plant for one year, at the end of which he would be qualified to take charge of a small plant, where conditions of operation were altogether different from the large plant. Then he should be moved to the chief's chair in some large, up-to-date plant, where conditions were again different. I should have him here until such time as the manager of some other large plant had heard of him and sent to investigate him and his methods.

F. M. J.

Packing for Rubber Mill Rollers

IN THE May 15 issue of Practical Engineer, advice is asked regarding packing rolls of rubber mills, and while the answer given is good, I believe the method I have used of handling this proposition will be interesting.

In this plant, where I am master mechanic and engineer, much trouble was experienced in keeping the stuffing boxes of the rolls tight. Whatever we packed them with they would, in a few days, be leaking, and the space around the rubber mill would be wet and slippery. We tried a number of packings that I knew were good, but could find nothing that would stand the strain in this service.

Briefly, in the rubber industry, mills are used for mixing or grinding the rubber, and it is necessary that the rolls be brought to a certain temperature before grinding of stock is attempted. This is done by the use of steam before the machine is put into service; but once in service, the stock will keep the machine rolls at the necessary temperature, so that steam is shut off, and if the machine is mixing rubber compounds, it is necessary to keep the rolls cool with water, which is supplied through the same stuffing box arrangement as was the steam.

It will thus be seen that the packing is subject to considerable difference in its work,—if a steam packing is used, it will not hold up against the water, and again, if we use a water packing, it will go to pieces under the action of the hot steam. In addition to this, there is a deal of heavy work put upon packing in this service.

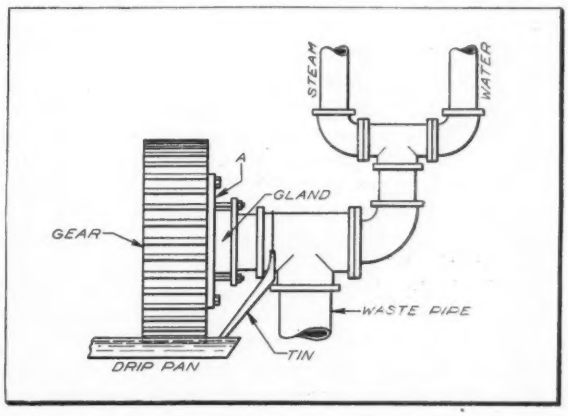


FIG. 1. CONNECTION TO ROLLER; SHOWING GLAND, WATER DRAIN AND METHOD OF LUBRICATING GEARS

Looking at it every way, we thought a good hydraulic and steam packing was what was needed; but after trying some combinations along this line, I came to think that we were on the wrong track and that the idea was not good. One reason that stopped the use of any hard flax or hemp packing around these machines, is that much of the help in a rubber industry is of the $9-a-week class, and if the box leaks, their idea is to get a good strong wrench (an 18-in. Stillson wrench is as

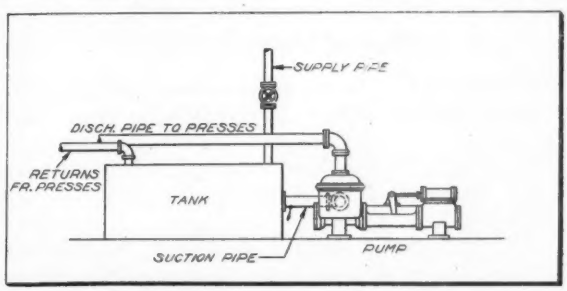


FIG. 2. WATER SUPPLY SYSTEM TO PRESSES

good as anything else) and tighten up until the leak stops. This creates, of course, excessive friction and wears the rods on machines, so that a hard packing will cut the rods badly in a short time, while a soft packing, as a general thing, will go to pieces. After studying the proposition a good deal, I tried the method shown with excellent results.

Figure 1 gives the general construction of the boxes used in this work, the plate A being attached to the end of the roll by set screws, and on the end of the roll is the connecting gear, with a drip pan underneath to collect grease or oil used on the gears. First, I packed the boxes with a good grade of steam packing, which had been soaked for 2 days in heavy cylinder oil. I

then attached to the piping a piece of sheet tin, one end of which rested in the drip pan as shown, so that any water leaking from the boxes goes into the drip pan and raises the oil to the gears. I thus have a splendid method of lubricating the gears and getting rid of the water around the machines. In fact, it is killing 2 birds with one stone. I have a ¼-in. overflow pipe from the drip pans; but by going over the mills twice a week, I am losing but little water, and I allow nobody but myself to take up on the boxes. The method is giving excellent results.

While speaking of packing, I might mention a little "stunt" which was tried out with good results. Our outside packed plunger pump is used to keep a pressure of about 3500 lb. on some presses. It has been quite a proposition to keep those plungers tight, and recently I found the rods becoming badly scored. After thinking a good deal, I came to the conclusion that lubrication was needed, and oils and greases were tried, with indifferent results, and graphite did little better.

In Fig. 2, the piping system to and from the pumps is shown, the tank being filled with water from the supply pipe A, and when the tank is full, this valve is closed and locked. The pump takes water from the tank, forces it to the presses, and the presses discharge back to the tank, so that the same water is used repeatedly for about a month, letting in a little each week to replace leakage. Once a month the tank is washed out and refilled, and about 2 months ago, just before the refilling, I cut up a 3-lb. bar of Olive soap and threw it into the tank, with surprising results. In the first place, the packing is holding up splendidly; second, the rods are as smooth as glass, and third, the pumps are working much easier than they have been in the past. Incidentally, the leaks around the rams of the presses have stopped, which is also worth considering.

ARTHUR D. PALMER.

Blowing Down Boilers

I HAVE read with considerable interest, the article by Frank Bohe, in May 15 issue—"Do Not Blow Down Boilers."

He asserts: "That the old method of blowing down boilers is wrong, I can prove to any reader of this publication."

If it is wrong to blow down boilers, why does he find it necessary to blow down B. & W. boilers or any water-tube boilers every day about 6 sec., just enough to remove the mud from the mud drum? He admits that the mud is "liable to bake on the 2 bottom rows of tubes and cause a bulge or blister."

He also says: "In return-tubular boilers, you must be more careful."

All this—bulging and blistering—would occur in overworked boilers. With his method, in boilers that are not overworked, would not the mud settle just the same, harden and become, in the end, scale, scaly tubes resulting? He "does not allow any of his men to touch the blowoff until the boiler is taken off." Would it not be just as well to keep the mud on the move out, rather than to let it accumulate, with the attending risk of bulge or blister, even though it did cause a little waste of boiler compound? If I were to follow Mr. Bohe's method, I am afraid I should be blowing the company's money "up" instead of away. I propose to give some of my experience with the plant of which I now am in charge, the Cape May City, N. J., waterworks, owned and operated by the City of Cape May, for the benefit of its citizens. The chief engineer is in absolute charge of all machinery, boilers, etc.; suggests and advises all purchases; selects coal, oils, boiler compounds, etc.

In taking charge of this works, 6 yr. ago, I found 2 120-hp., return-tubular boilers, with an accumulation of scale from ⅛ to ¼ in. in thickness. I tried boiler compound and scaling tools, using a number of compounds during the 6 yr. The manufacturers of these compounds advised the blowing down of boilers at least once in every 10 hr. Our boilers are in continuous 24-hr. service, and are blown down every 12 hr. During the summer season, both boilers are in continuous service for about 95 days with no spare boiler to cut in, in order that boilers may be cleaned.

In May, 1913, by mere accident, I read an article written by an engineer who had precisely the same trouble with scale that I was having. This engineer had entirely removed the scale from his boilers, and at the time the article was written, none was forming. This was produced by the use of boiler graphite.

I immediately made out a requisition for 100 lb. of the grade of graphite suggested. Upon receiving the graphite, I began using it in both boilers. I was afraid to use according to directions, fearing to precipitate the scale in such quantities as to be dangerous, using only 4 oz. in 24 hr. in each boiler, following directions as to blowing down, which was, blow each boiler down once every 12 hr. As stated, the boilers, in summer, are in continuous service for from 90 to 95 days.

We opened No. 2 boiler 93 days after beginning the use of graphite, and cleaned thoroughly, removing 25½ lb. of scale. About a week later, we cleaned No. 1 boiler, removing 49 lb. of scale. The tubes and sheets of both boilers have a thin coating of graphite, which prevents new scale from forming.

In 1912, both boilers were in service at the same time of year and about the same number of days. When the boilers were cleaned, we removed from each, 350 lb. of scale.

I am still using graphite. Both boilers are in fine condition, and so pronounced by the inspector of the Hartford Steam Boiler Insurance and Inspection Co. Had I not blown down the boilers twice in 24 hr., what would have been their condition at the close of the summer season?

FRANK C. B. SPEACE.

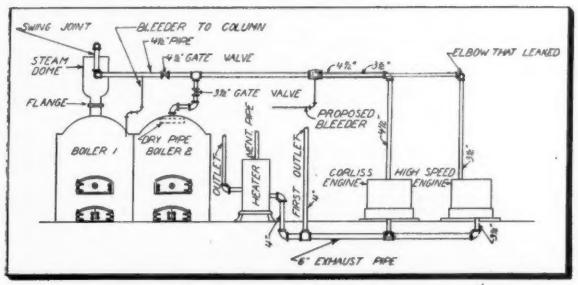
Peculiar Exhaust and Steam Lines

FOR 2 YR. I have stood under this steam line, which furnishes power to a 14 by 36-in. Allis-Chalmers Corliss, and a 12 by 12-in. high speed Ideal direct connected unit. Boiler No. 1 was in service and had not been connected up with No. 2 yet. As we have a long steam line, it was hard to keep steady, until I hooked up with boiler No. 2. I followed the practice for several months of blowing out a large pocket of water at starting time.

The first trial of the newly hooked up boiler told me that my steam line was higher at the engine end. There

was no water to blow out, for through the day it drained back into the boiler. I then cut in a bleeder and connected to the top of my water column and have no trouble now. Before, it was dangerous to start up the engines without first blowing out the water. I have thought about tapping in another pipe at the second large tee to engine. The pipe is reduced from 4½ in. down to 3½ in., which makes quite a water trap. One leak developed at an elbow near the high speed engine. By calking, the trouble was overcome.

The exhaust line has given me a little trouble. We had to renew 16 ft. of 6-in. pipe, the old pipe was buried in cinders, and there was enough moisture to cause the pipe to become eaten up. The bulk of the steam goes up the first line of 4-in. pipe. What remains goes into a Cookson heater. The water is very hot, but this heater never scales up any, which seems strange. The pumps exhaust into the heater. I have some trouble with the overflow pipe getting stopped up with strips of piston packing, which works through the heater. I think the outlet steam pipe ought to be on top instead of the side. The only vent pipe they had was ½-in. I put on a larger pipe, which increased the temperature of the water.



PIPING WHICH GAVE TROUBLE

When the overflow pipe clogs up, the feed water temperature goes down and the condensed water works down and up the first line of exhaust pipe, which makes a back pressure on the engine and showers on the roof part of the time. If the heater was large enough, a better plan would have been to carry the 6-in. pipe into the heater. G. H. Brough.

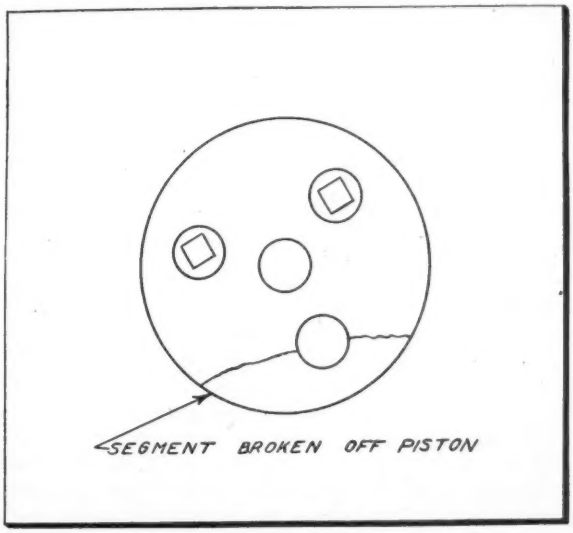
(While the piping system described above is far from the best possible, and most of the defects have been pointed out by Mr. Brough, we wish to call attention to the bleeder connection he has made from the header to the top of the water column. There should never be a connection between a steam line and the water column, as it will affect the height of water in the column, giving the fireman an incorrect reading in his gage glass.—Editor.)

Broken Piston

Some time ago, while running as assistant engineer in a large sugar factory, I had, besides the Corliss engine, 2 high-speed engines direct-connected to generators under my charge. One night a slight knock developed in the cylinder of No. 2 engine. I thought the sound came from a knock on the crosshead pin. As the knock kept getting worse all the time, I called the chief, and he thought it was caused by water in the cylinder; but when he opened the cylinder cocks, the pound became exceedingly worse and could be noticed only on the head end. I suggested shutting the engine down and opening up the cylinder, but he said to let it go until morning and let the day crew look after it.

About an hour later, as the chief was passing by this engine, there was an awful chug that could be heard all over the mill, the lights flickered and a slamming and banging sounded equal to a Gatling gun. As the chief was near the throttle at the time, he immediately shut the steam off.

When we took the cylinder head off, we saw immediately what was the trouble. This piston was of the built-up hollow type with 3 2-in. plugs screwed into the head end face of the piston. These plugs were spaced equally distant around the piston. One of them had come loose and begun to back out and finally had come all the way out and dropped into the clearance space. On the return stroke, the piston had jammed it against the head of the cylinder, with the result that a large



THE BROKEN PISTON SHOWING PLUG OUT

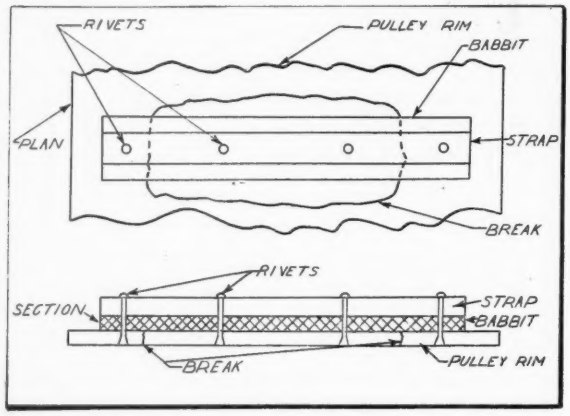
segment of the piston was broken off, the bottom of the cylinder slightly cut and a large chip broken off the inside of the cylinder head. As we had our own machine shop, the machinists were immediately put to work repairing the damage and, by noon the next day, the engine was running again.

In this same plant, the big Corliss engine in the pulp drier engine room broke the crank off the head end exhaust valve close to the shoulder. Upon trying to remove the valve, it was found stuck so tight that it had to be driven out. In modern sugar making, all the exhaust steam is used for cooking and heating purposes and the condensation is used for boiler feeding; frequently the coils in the cooking pans spring a leak and some of the juice gets into the condensation, then into the boilers, where it forms a kind of molasses, causing the boilers to prime, and bringing this molasses into the engines, causing the valves and pistons to groan, and it is necessary to use an extreme amount of oil to cut this sticky syrup off. This is thought to be the cause of the sticking of the valve in the engine mentioned before.

Walter B. Brown.

Repairing a Pulley

REFERRING TO Hawley L. Scott's article in the April 15 issue on repairing a pulley, Mr. Scott may be interested in a little kink that I have used several times and which is useful in mending breaks in cast metals. The method is illustrated in the cut, in which I show a break in a cast-iron pulley similar to the break in Mr. Scott's pulley. I, however, find it unnecessary to bend the iron strap to conform to the curvature of the pulley. I merely drill the 2 end holes, and put the end rivets in place, loosely. Then I place the broken-out part in the desired final position, build a mold around the iron



METHOD OF REPAIRING BROKEN PULLEY RIM

strap and pour in some babbit metal to give the strap a perfect bearing surface. Then, all that is necessary is to drill a couple of holes through the broken part, babbit, strap and all, and carefully rivet in place. The babbit metal holds the broken piece just where it should be, so there is no rough edge to harm the belt.

In case this makes one side of the pulley too heavy, it is practical to place a balancing weight on the other side, which may be made of almost any available material.

N. G. NEAR.

Emergency Arch for Return-Tubular Boiler

SEVERAL years ago, I had a plant of 3 boilers with flat cast-iron plates for arches. One of these was in bad shape, being warped so the tubes in 2 upper rows were exposed. I found this when I took the plant and tried to change the plate so as to bring the edge, then resting on back wall, against the head. We dropped the plate and broke it in 3 or 4 pieces. This was Sunday morning and no plate closer than 10 miles, and boiler to go on at 5 a.m. Monday.

As part of the back and side wall went with the plate, we arranged to rebuild it while I figured a way out. This was a 72-in. boiler and the other 2 were 60-in., so I could not take their plates. Fortunately, we were on a railroad, so I took 2 old pieces of rail and cut them off to suitable length, placed one at the rear head and the other on the back wall, then got 6-hole angle bars, or fish plates, as some call them (they are used where rails are bolted together), and slid them into the groove between top and bottom of rails, spacing them so a fire brick set on their edges. The whole outfit was then closed in by fire brick at sides and covered with fire clay. After an hour or two, a light fire was built and arch allowed to dry.

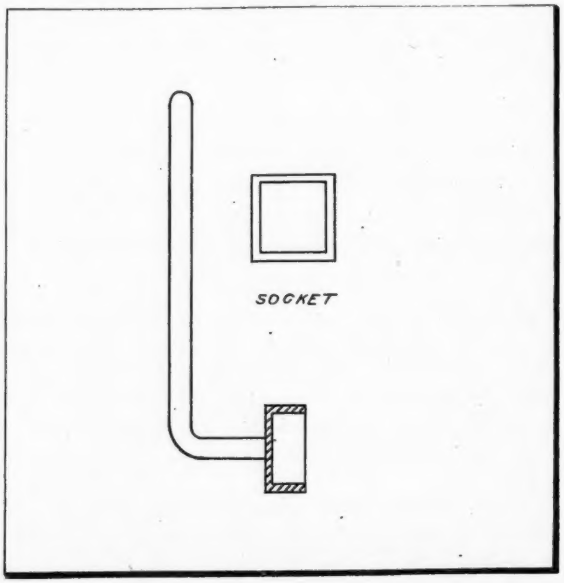
As no leakage showed with the damper closed, I concluded to give it a trial for Monday. It worked O. K., and was still there 6 months later, when I left the plant.

J. C. LEE.

Renewing the Fusible Plug

I HAD an experience, 4 or 5 yr. ago, with a fusible plug melting out for no reason I could think of at that time, as at the time the plug blew out, there were 7 or 8 in. of water above the plug. We were filling the boiler with water, due to being close to quitting time. The plug was clean outside and inside, as it had been in use for only 2 weeks. I believe the blowing out of the plug was due to some defect in the material with which it was filled.

To make a repair, the fire was drawn at once, the steam was blown out of the boiler and water run out until it came below the opening for the fusible plug. As we had the back connection covered with a removable half arch, which was in 3 sections, the middle section, which was directly over the plug, was removed,



WRENCH USED FOR REPLACING FUSIBLE PLUG

the plug taken out and a new plug put in place, then the boiler was filled with water again. This work was done in about 2 hr.; if we had had the old style of setting over the back connection, it would have been necessary to let the boiler stand for some time, so the back connection would cool off before we could enter to remove the plug.

In order to avoid rounding the corners of the plug, I use a bent socket wrench of heavy construction, as shown in the illustration.

I also cover the threads with graphite mixed with cylinder oil, when they will come out more easily the next time.

H. JAHNKE.

Questions Answered and For Answer

Expert Help When In Trouble. If You Want Quick Answer Enclose a Stamp

Electrical Questions

WHAT SIZE of line wire should be used to transmit current for 2000 16-c.p. lamps, 60 w. each, which are to be operated at a point 8000 ft. from the station? The e.m.f. at the transformer is 2080 v.; the loss in the line is 10 per cent of the power delivered; allow 2 per cent of the power delivered to the lamps for loss in the secondary wiring. Transformer efficiency is 95 per cent, single-phase current to be used.

2. When a voltmeter having a resistance of 18,000 ohms was connected across a circuit, it showed 115 v.; when connected between the ground and one line, it showed 10 v. What was the insulation resistance of the other line?

3. The power factor of a 500-v., 3-phase induction motor is 0.85, and at full load the motor takes 25 hp. from the line; what will be the full load current in each wire?

4. A recording wattmeter reads 8900 w.-hr. at the beginning of the month, and 25,000 at the end of the month. The constant is 2. The power is worth 5 cents per hp.-hr. What is the bill for the month?

5. Suppose a coil wire wound on an iron ring has a resistance of 5 ohms, an inductance of 0.5 henry, and the impressed e.m.f. is 100 v. alternating; frequency 30 cycles per sec. What current will flow through the coil?

6. (a) How does capacity in a line affect the phase relation between the e.m.f. and current?

(b) If a line has self induction, what device could be connected to it to neutralize partly the self inductance?

7. If a 60-cycle alternator is connected to a circuit that has an inductance of 0.08 henry, and a resistance of 15 ohms, what e.m.f. must be supplied by the alternator to force a current of 15 amp. through the circuit?

8. What is a wattless current and how is it caused?

9. If the open space between the sides of a coil on an alternator armature is much less than the width of a pole face, what will be the effect on the terminal e.m.f.?

A. Power delivered at lamps $= 2000 \times 60$ w. $=$ 120,000 w. Loss in secondary wiring $= 2$ per cent of 120,000 w. $= 2400$ w. Power delivered by transformer secondary $= 120{,}000$ w. $+ 1200$ w. $= 122{,}400$ w.

Since transformer efficiency is 95 per cent, then, Power delivered by transformer secondary terminals $\div$ Power delivered by transformer primary terminals $=$ 95 per cent. Or,

Power delivered by transformer secondary terminals $= 0.95 \times$ power delivered to transformer primary terminals. Or,

Power delivered to transformer primary terminals $=$ $100/95 \times$ power delivered to transformer secondary terminals $= 100/95 \times 122{,}400$ w. $= 128{,}842$ w.

The mathematical equation for the current in the primary circuit is,

$$I = \frac{W}{E \times P.F.}$$

Where I = current in primary circuit;
E = voltage at primary terminals of transformer.
P. F. = power factor, a ratio depending upon phase relation between pressure and current.
W = power in watts delivered to transformer primary terminals.

In this case we have,

$W = 128{,}842$ w.;
$E = 2080$ v.;
P. F. may be assumed to be 95/100.

Substituting these values in the above equation, we have,

$$I = \frac{128{,}842}{2080 \times 95/100} = 65.2 \text{ amp.}$$

Assuming that in the statement:

"The loss in the line is 10 per cent of the power delivered to the transformer primary terminals,"—the line loss is $10/100 \times 128{,}842$ w. $= 12{,}884$ w.

The mathematical equation for the apparent line resistance is $R^1 = \frac{Wl}{I \times I}$.

Where R^1 = apparent line resistance in ohms;
Wl = power in watts lost in the line;
I = amperes current in the primary circuit;

In this case, $Wl = 12{,}884$ w.
$I = 65.2$ amp.

Substituting, $R^1 = \frac{12{,}884}{62.5 \times 62.5} = 3.03$ ohms.

The distance the current travels out and back is 2×8000 ft. $= 16{,}000$ ft.

Resistance per 1000 ft. is $\frac{3.03}{16} = 0.19$ ohms.

Consulting a wire table, we find that No. 3 wire has a resistance of 0.197 ohms per 1000 ft., and No. 2 wire a resistance of 0.156 ohms per 1000 ft.

Taking the wire of next lower resistance, we select No. 2.

Assume spacing of conductors to be 12 in.

From the table of Resistances and Reactances below,

we find the reactance of No. 2 wire for a 12-in. spacing of conductors and for a frequency of 60 cycles, to be 0.58 ohms per ½ mi. of double line. Or, reactance for a double line 8000 ft. long is

$$\frac{8000}{2640} \times 0.58 = 1.76 \text{ ohms.}$$

$E_0 - E = RI^1$.

Where E_0 = station voltage, or

$E_0 = IR^1 + E = 65.2 \times 3.03 + 2080 = 2295$ v.

The true resistance of a single-phase transmission line may be found by subtracting from the station voltage E_0 squared, [the sum of the voltage at the primary terminals of the transformer times sin a and the resistance times the current flow] squared, minus [the transformer primary voltage times the cos of a.]

The above, after having extracted the square root thereof, and dividing by I, will be the resistance of the line.

Cos a = power factor.

From a table of sines and cosines we have, from the angle whose cosine is 0.95, the sin = 0.31, or sin a = .31. Station voltage = 2295.

SIZE WIRE B.&S. GAGE	RES. IN OHMS	OHMS REACT.-60 CYCLES PER SEC. WIRES 12" APART	WIRES 18" APART	WIRES 24" APART
0000	.259	.508	.557	.591
000	.324	.523	.573	.607
00	.412	.534	.588	.618
0	.519	.550	.603	.633
1	.655	.565	.614	.648
2	.826	.580	.629	.663
3	1.041	.591	.644	.674
4	1.313	.606	.656	.690
5	1.656	.620	.670	.704
6	2.088	.633	.685	.720
7	2.633	.647	.700	.730
8	3.320	.662	.712	.742
9	4.186	.677	.727	.761
10	5.280	.688	.742	.776

(Transformer terminal voltage times sin a, plus reactance, times current) squared = $(2080 \times 0.31 + 1.75 \times 65.2)^2$;

Transformer terminal voltage times cos a = $2080 \times 0.95 = 65.2$. Or,

$$R = \frac{\sqrt{(2295)^2 - (2080 \times 0.31 + 1.75 \times 65.2)^2} - 2080 \times 0.95}{65.2}$$

= 2.84 ohms.

For wire 16,000 ft. long, resistance per 1000 ft. = $\frac{2.84}{16}$ = 0.177 ohms. From wire table as above, No. 2 wire has a resistance of 0.156 ohms per 1000 ft., so we select No. 2 wire.

2. $R = r\left(\frac{d}{d_1} - 1\right)$

R = resistance to be measured.

r = voltmeter resistance.

d = deflection across line.

d_1 = deflection with R in circuit.

Substituting numerical values,

$$R = 18{,}000 \times \left(\frac{115}{10} - 1\right) = 189{,}000 \text{ ohms.}$$

3. The algebraic equation of power in a 3-phase circuit is,

$$W = \sqrt{3} \times E \times I \times \text{P. F., or } I = \frac{W}{\sqrt{3} \times E \times I}.$$

Where W = power in watts,

E = voltage between phases,

I = amperes current in each phase,

P. F. = power factor.

The power is 25 hp., or 25×746 w. = 18,650 w., since 1 hp. = 746 watts.

Then $I = \frac{18{,}650}{1.732 \times 500 \times 0.85} = 25.4$ amp.

4. 25,000 w.-hr. — 8900 w.-hr. = 16,100 w.-hr.

$2 \times 16{,}100$ w.-hr. = 32,200 w.-hr., actual energy used.

$\frac{32{,}200}{746} = 43.2$ hp.-hr.

$43.2 \times \$0.05 = \$2.16$.

We find the current by dividing the voltage by the square root of (the resistance squared, plus the square of 2 times 3.1416 times the frequency in cycles per second times the inductance in henrys.)

Substituting the proper values therein, we have,

$$I = \frac{100}{\sqrt{5^2 + (2 \times 3.1416 \times 30 \times 0.5)^2}}$$

6. (a) It causes the current to lead the e.m.f. where there is no inductance. Where there is inductance, the capacity tends to overcome its effect, thereby bringing the current more nearly in phase with the e.m.f.

(b) Connect up a synchronous motor with over-excited field.

7. From answer to Question 5,

$$E = I\sqrt{R^2 + (2 \times 3.1416\, fL)^2}$$

$$= 15\sqrt{(15)^2 + (2 \times 3.1416 \times 60 \times 0.08)^2}$$

= 505 volts.

8. One that does not require power to force it through the circuit. Its pulsations are exactly ¼ of a cycle behind or in front of those of the voltage.

When the instantaneous current is at maximum value, the instantaneous e.m.f. is at zero, and vice versa.

A circuit composed entirely of inductance, or entirely of capacity, would have a wattless current flowing.

This is really a theoretical case only, since there is always at least a little resistance.

It is customary to consider a current not in phase with the e.m.f. as composed of 2 currents, one in phase with the e.m.f. and the other a wattless current.

9. The terminal e.m.f. will be reduced, owing to the fact that some of the coils in the armature will be in opposition to the rest.

Ice Machine Trouble

I HAVE, in a plant where I am employed, a 17-ton Triumph ice machine, which is used for refrigerating. On starting up in the morning, the coils will freeze quite rapidly until about half of the coil is frozen, then it will start to thaw off nearly to the expansion valve and then again freeze. Sometimes it will last for 2 hr., then the frost breaks in about the center of the coil and thaws both ways and it will then only hold a cold sweat, the valves being left in the same position, the pressure gage showing 115 lb. and the suction gage 15 lb. during the whole run.

Three of the coils are 40 ft. long and contain 14 2-in. pipes, and one coil is 40 ft. long of 14 1¼-in. pipes. They are all above the compressor, being on the fourth floor, and it is about 180 ft. from the king valve to these coils, which are all supplied from one ½-in. liquor line, this line not being covered.

1. Would it not be good to cover this line as it runs through a hot engine room, then up through 2 more hot rooms before it gets to the fourth floor, where it is expanded into the coils mentioned?

2. How can I avoid getting a back pressure of 100 to 150 lb. on the suction or low side of the system? This pressure rises during the night after closing down in the evening. First, I always close the king valve, then go and close my expansion valves at the coils and pump the low side down to zero.

3. The coils I mentioned hang on the ceiling, 7 abreast return bends at one end, and 6 at the other, the inlet and outlet taken off at the end. Is it possible that liquor will accumulate in these coils, as they have no grade (as for gravity drainage), but lie quite level? As our ammonia seems to disappear and have no leakage, excepting that caused by the high rise of pressure overnight, as mentioned, the pressure carried on the working side is from 100 to 115 lb. and on the low side from 10 to 15 lb. during the whole 10-hr. day run. The compressor is 9 by 12 Triumph double-acting and runs 84 r.p.m.

I would like the advice of someone to overcome these troubles, or make some good improvements over them.

W. F. N.

A. By all means, cover the liquid line and also the liquid receiver. In an ammonia system, there are 2 distinct sides. One of these is the part of the plant from the compressor through to the expansion valves. This side, known as the high pressure side, is doing the work of taking the heat out of the ammonia which has been taken up from the evaporating coils. All parts of this side that comes in contact with the surrounding atmosphere hotter than the ammonia, should be covered. That would mean to cover the liquid line from the condenser to the liquid receiver, and the liquid line to the expansion valves. The liquid receiver should be placed in as cool a place as possible. A good way to cover the liquid line is to run the liquid and suction lines right together as much as possible and cover them with one covering.

2. Leaky valves are the trouble. The king, or main liquid valve, and also the expansion valves, are leaking; so that, after the compressor is shut down, the pressure equalizes in the condenser and the evaporating coils. That will explain the high suction pressure when starting up. The frost that comes and goes is accounted for by the liquid which becomes stored in the coils during the night and which evaporates as the machine lowers the suction pressure.

The liquid valve has, most likely, a babbit or tin disc and this can easily be renewed by melting out and pouring in new metal. The expansion valves will have to be ground in with fine emery or perhaps they also have a soft disc. Get all the valves tight, even though new ones have to be installed.

In most cases, when it is found that a coil begins to lose the frost in some spot and melt both ways, the reason will be found to be a partial blocking of some kind in the coil. Quite often, when sweating flanges on pipe and using a sweat box in which the pipe is set on end, a slug of solder will lodge in the pipe and either partially or completely block it.

Disconnect the coils where the frost begins to melt and examine for obstruction.

3. As for having a pitch in the evaporating coils to drain them, that is neither necessary nor even good practice. A great many manufacturers of ice and refrigerating plants install what is commonly called the bottom feed system, in which the ammonia is admitted to the bottom pipe of the coil and the gas or vapor is taken off at the top. It is generally claimed that this system is more efficient than the top feed, as more liquid is contained in the coil, and evaporation takes place throughout the full length.

A. G. SOLOMON.

Power of Water Motor

HOW DO you compute the power of a water motor when the static head is 40 ft., friction loss 5 ft. and a flow of 100 cu. ft. of water per minute?

L. K.

A. The net head to produce power at the motor will be the total minus the friction, which in this case is 40 — 5, or 35 ft. One hundred cubic feet at 62.5 lb. per cu. ft. will give a weight of 6250 lb. per min. This times 35, the head, will give 218,750 ft.-lb. per min., which at 33,000 ft.-lb. per hp., would be 6.63 hp. delivered to the motor.

Assuming an efficiency of 60 per cent, the motor would deliver 6.63 × 0.60 or 3.978 hp. Of course, the efficiency is an assumption, and we have no means of knowing how close that will be to the facts. A. L. R.

Cost of Piping

I HAVE been trying to find some process for estimating the cost of piping, as we are frequently making changes in the different departments of our 300-hp. plant, and the first question asked is, "How much will it cost?" I have figured up a number of times, and 3 times came out all right, but several times was way below the final cost.

Can anyone give a method for figuring the cost of fitting up pipe, either by a percentage of the cost of material, or by any other method? We are able to figure the cost per horsepower of buildings of certain construction, and for the equipment of a plant. What is wanted is some similar method of figuring the cost of piping.

T. A. H.

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The Flat Boiler Efficiency Curve

In the design of modern boiler plants, the tendency is towards a combination of furnace and boiler which will give a flat overall efficiency curve throughout a long range of the load. The plant so equipped that its efficiency curve is very peaked, must be operated at its point of highest efficiency, if best results are to be obtained from it, but such operation is inconvenient in many plants, necessitating the breaking in of boilers when they are only partly cleaned, wasting coal for banking or cutting in and taking out the extra boiler, besides the extra work upon the fireman in having another fire to watch.

From the standpoint of economy, it has proved best to equip the plant so that it is not necessary to put extra boilers into operation to care for the peak load.

The practice followed in some plants is to operate the boilers at from 90 to 110 per cent rating during off peak periods, at which loads they usually operate most efficiently, then when the peak comes on, the same boilers are forced to take care of the load, even if this be as high as 230 per cent rating, at a falling off in efficiency of not over 4 per cent. This practice depends somewhat upon the load factor of the plant, but the principle can be worked in nearly all plants.

In order that this practice may give best results, it is necessary that the overall efficiency of furnace and boiler shall be constant, or nearly so, at all loads throughout the range of operation; such a condition is approximately attainable, being largely a matter of furnace design and operation, since, without doubt, the controlling factor in the combined efficiency of the furnace and boiler is the furnace, for slight changes in only one of the many variable furnace conditions will have a decided effect upon the efficiency of the boiler room, while with the boiler proper, in good working condition, its ability to transfer heat from the furnace gases to the water is nearly directly proportional to the difference in temperature. Thus, a rapid circulation of gases on one side of the heating surface is accompanied by a rapid circulation and evaporation of water on the other, temperature and pressure conditions being maintained constant.

Difficulty, however, arises when forcing fires to maintain the furnace conditions such that its efficiency does not vary greatly throughout a long range of load. At the present time, the determination of the percentage of CO_2 present in the flue gases is the only practical means we have of determining the efficiency of combustion. This, together with temperature indications of furnace and flue gas, form excellent guides to firemen in operating boilers.

According to E. C. Fisher of the Wickes Boiler Co., driving steam boilers at a high rate of evaporation is largely controlled by 3 factors: First, obtaining rapid and perfect combustion with high furnace temperature; second, the best possible flow of gases over the heating surface to assist transmission of the heat to the water; third, the best possible arrangement of the heating surface to promote abstraction of the heat and durability of the structure.

The first of these factors is the only one which is subject to great variation, as it depends to a great ex-

tent upon the methods of firing employed, while the other factors are almost entirely matters of design and can be changed greatly only by reselection of boilers or redesign of baffles.

While selection of equipment and design of boiler settings have made possible the forcing of boilers to take care of peak loads economically, the plant must still look to its operating force if the efficiency of the plant is to be maintained, and this desirable flat curve obtained.

News Notes

A COMMITTEE HAS BEEN APPOINTED by the Commercial Club of Hazel, Ky., to investigate the cost of a light and water plant for the town.

THERE IS A MOVEMENT on foot to establish an electric light plant and waterworks in Jonesboro, La. M. C. Jenkins, electrician at the Tremont mill, has the enterprise in hand, has been corresponding with outside capitalists and is now at work estimating the cost of construction. His purpose is to form a private stock company, capitalized at $25,000. A site has been offered and material steps will be taken in the near future.

SASKATCHEWAN BROTHERHOOD of Steam and Operating Engineers is to hold an exhibit of power plant apparatus and supplies on July 28 to 30, at Regina, Sask., in connection with the big Provincial Exhibition. Besides the exhibit, there will be a series of lectures on important engineering topics by leading engineers of the Dominion of Canada, and a civic welcome to the engineering fraternity. Information in regard to the exhibit, spaces and other arrangements, can be had from H. J. Fox, Secretary, Provincial Normal School, Regina, Sask.

U. S. CIVIL SERVICE COMMISSION announces an open competitive examination for mechanical draftsman, on July 22 and 23, 1914, to fill vacancies as they may occur in this position, in the Panama Canal Service, at entrance salaries ranging from $125 to $150 a month. Competitors will be examined in the following subjects, which will have the relative weights indicated: Machine design (including arithmetic, algebra to quadratics, geometry, mensuration, logarithms, use of tables, elementary problems in mechanics, use of slide rule, materials used in machine construction, and practical calculations involving the interpretation of formulas and the correct working out of results in special cases), 30; drafting (involving competent knowledge of machine construction and the ability to draw neatly to scale), 35; training and experience, 35. An applicant who has not had sufficient training and experience to entitle him to a rating of at least 70 in this subject will not be eligible for appointment. Competitors who attain over 80 per cent in training and experience will be rated as first-class draftsmen. First-class draftsmen must indicate in their applications that they have not had less than 3 years' good drafting-room experience, and, in addition, shopwork experience or on machine construction. A technical school training in mechanical engineering will be equivalent to 2 years' practical work. Second-class draftsmen must indicate in their applications that they have had not less than 2 yr. in drafting room, or 1 yr. in drafting room and 1 yr. in the shop or on construction. A technical school training in mechanical engineering will be accepted as equivalent to the 2 yr. practice. Applicants must have reached their twentieth but not their forty-fifth birthday on the date of the examination. Each applicant will be required to submit to the examiner, on the day he is examined, a photograph of himself taken within 2 yr. In applying for this examination, ask for Form 1312, using the title Mechanical Draftsman (male).

U. S. CIVIL SERVICE COMMISSION announces an open competitive examination for chemical engineer, Aug. 3, 1914, to fill a vacancy in this position in the Bureau of Mines, Department of the Interior, for service at Pittsburgh, Pa., at a salary ranging from $2000 to $4000 a year. Duties will be to conduct investigations in applied physical chemistry in its relation to fuels, oils, and gases. Competitors will not be assembled for examination, but will be rated on the following subjects, which will have the relative weights indicated: General education and scientific training, 40; professional experience and fitness, 40; published or manuscript reports, 20. An educational training equivalent to that required for the degree of Doctor of Philosophy from a college or university of recognized standing, and at least 5 years' experience in chemical investigations of fuels, oils, or gases, are prerequisite for consideration for this position. Applicants must have reached their twenty-fifth but not their fortieth birthday on the date of the examination. In applying for this examination, ask for Form 304, using the title, Chemical Engineer (Male).

UNITED STATES CIVIL SERVICE COMMISSION announces an open competitive examination for metallurgical engineer, for work in iron and steel, to fill a vacancy in this position in the Bureau of Mines, Department of the Interior, for service at Pittsburgh, Pa., at a salary ranging from $3000 to $4500 a year. The special duties will be to conduct inquiries and investigations into both safety and efficiency problems in the metallurgy of iron and steel.

Competitors will not be assembled for examination, but will be rated on the following subjects, which will have the relative weights indicated: General education and technical training, 30: professional experience and fitness, 40; publications or reports, 30. An educational training equivalent to that required for graduation from a college or university of recognized standing, such training to have included courses in chemistry, physics, and metallurgy, and not less than 6 years' experience in metallurgy and metallurgical engineering in iron and steel mills, are prerequisites for consideration for this position. Applicants must have reached their twenty-fifth but not their forty-fifth birthday on the date of the examination. In applying for this examination, ask for Form 304, using the title, Metallurgical Engineer (Male), (For Work in Iron and Steel).

FOR RELIEF valves to remove water from the cylinder of an engine, a common size is one having the diameter 1/15 the cylinder diameter. This would give a 1⅝-in. valve for a 24-in. cylinder; but in case more water than is ordinarily encountered from condensation, is to be taken care of, a much larger relief valve should be used. For such cases, a valve not less than 3 in. in diameter should be employed on a 24-in. cylinder.

Power Apparatus in Shop and Market

New Ideas In Making, Buying and Selling

Volume Regulator for Air Compressors

USE OF SMALL AUXILIARY CHAMBER TO SECURE INCREASE OR REDUCTION OF RATE OF DELIVERY OF AIR. MAINTAINS CONSTANT PRESSURE

THE Hall Steam Pump Co., of Pittsburgh, has brought a device on the market which can be applied to any kind of air compressors with automatic inlet or outlet valves, or both, and makes it possible to control the amount of intake air, reducing the power required to operate the compressor in approximately the same proportion.

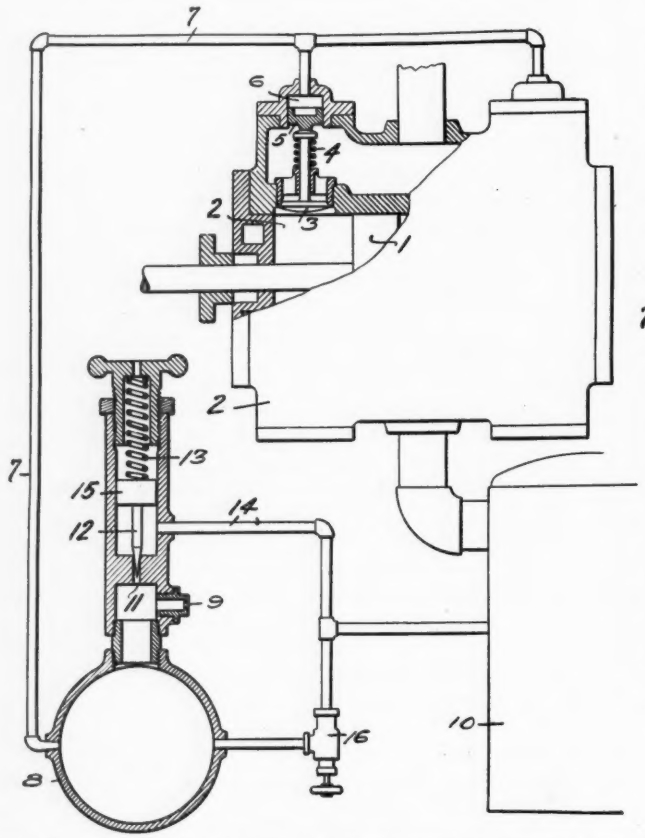


FIG. 1. APPLICATION OF REGULATOR TO POPPET SUCTION VALVE OF AIR COMPRESSOR

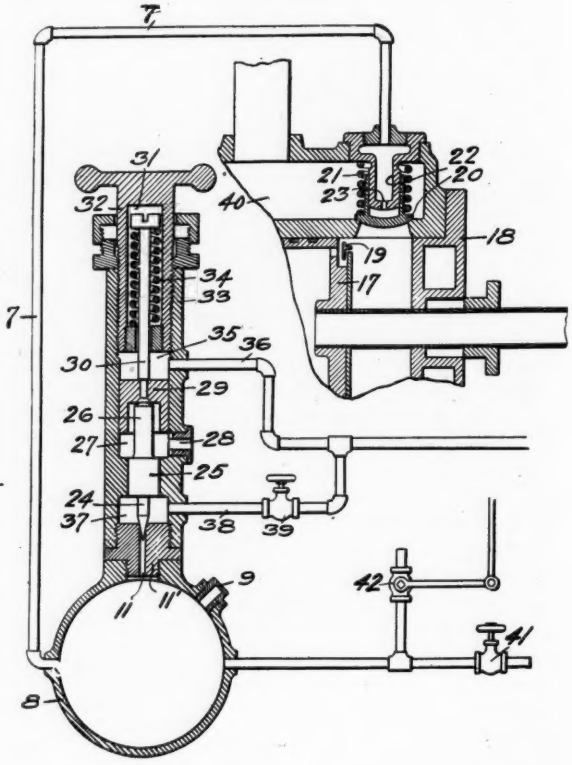


FIG. 2. REGULATOR APPLIED TO DISCHARGE VALVE OF AIR COMPRESSOR

The amount of intake air can be regulated—

1. So as to correspond to the amount of compressed air consumed at any time, thereby keeping the receiver pressure constant.

2. So as to decrease with increasing receiver pressure, thereby keeping the power required to operate the compressor constant.

3. So as to deliver any desired constant volume within the capacity of the compressor, or to fill almost any other requirement which the conditions of operation of an air compressor may impose.

DISTINGUISHING CHARACTERISTICS

IN CASE the automatic suction valves are used for the purpose of regulation, they are kept open by force during only a part of each discharge stroke and close

as soon as the amount of intake air remaining in the cylinder has decreased so as to correspond to the amount of compressed air desired at the time.

If the automatic discharge valves are used for the regulation, they remain forced open during only a part of the following suction stroke, and close as soon as the amount of compressed air returned into the pump cylinder is so great that it, after expansion to intake pressure, will leave sufficient room for the desired quantity of fresh air to enter the cylinder, during the last part of the suction stroke.

Adjustment is Gradual

The method, whereby the closing of the automatic valves at an adjustable point during the return flow of the air or gas is effected, consists simply in a gradual regulation of the force holding the valves open against the pressure exerted by their springs.

The return flow of the elastic fluid through the valves will produce a pressure tending to close them and this pressure will constantly increase until the piston has reached the end of its stroke, or nearly so. The valve will close at the point where this pressure, supported by the pressure of the valve springs, balances or overcomes the force applied for the purpose of regulation.

Application of this regulator to an ordinary poppet valve air compressor and acting upon its suction valves so as to keep the receiver pressure constant, is shown in Fig. 1. The piston, 1, works in the cylinder, 2, of a power-driven air compressor. The suction valves, 3, are provided with springs, 4, which tend to close them, and with pistons, 5, which are acted upon by the air pressure in the cylinders, 6. These cylinders are connected by means of a pipe, 7, to the auxiliary tank, 8. This tank communicates with the atmosphere through a leak, 9, and with the main reservoir, 10, through the opening, 11, which is closed by means of the pilot valve, 12, as soon as the force of the adjustable spring, 13, overcomes the air pressure of the reservoir, 10, acting through the pipe, 14, on the bottom of the valve piston, 15.

An adjustable needle valve, 16, can be arranged so as to obtain a constant leak from the main to the auxiliary reservoir, thereby preventing the pressure in the latter from decreasing below a certain value.

When the compressor is working at a constant partial load, the valve, 12, will allow some air to enter the auxiliary tank, 8, through the opening, 11, and the same quantity of air will escape through the leak, 9, thereby keeping the pressure in the reservoir, 8, and the pressure acting upon the pistons, 5, in the cylinders, 6, at constant. The suction valves will close at such a point of the discharge stroke as to compress exactly the quantity of air consumed, the pressure in the main tank, 10, remaining constant.

An increase (or decrease) in the consumption of air will cause a slight momentary decrease (or increase) of the pressure in the main tank, 10, and the quantity of air entering the reservoir, 8, through the opening, 11, will decrease (or increase) thereby decreasing (or increasing) the pressure in the reservoir and changing the cutoff of the suction valves so as to increase (or decrease) the amount of intake air until new conditions of equal supply and consumption of compressed air at the same pressure as before are established.

For a certain pressure in the auxiliary tank, 8, the air compressor will work at its maximum capacity, and the object of the adjustable needle valve, 16, is to admit constantly so much air to the auxiliary tank as to produce this pressure. If more air be admitted through the valve, 16, the capacity of the compressor will be reduced and the volume of the intake air will vary with the consumption only as long as the latter remains below this reduced capacity.

Applied to Piston Inlet Type

Figure 2 shows the application of the same principle to the regulation of the discharge valves of a piston inlet type of air compressor. The action of the device is similar to the one represented in Fig. 1, and will easily be understood in referring to the drawing.

When the compressor is working at a constant partial load, the air under pressure from the main tank will enter the chamber, 35, through the pipe, 36, and counteract the tendency of the spring, 34, to raise the piston, 29; this piston will therefore bear upon the extension, 26, of the piston, 25, carrying in the needle valve, 24, against the pressure entering the chamber, 37, through

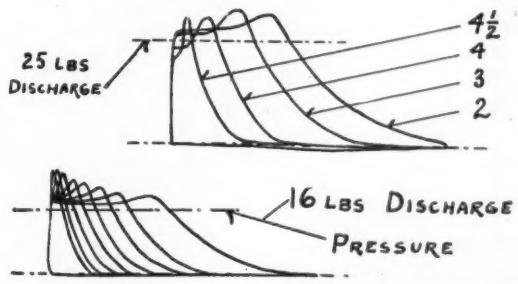


FIG. 3. DIAGRAMS FROM BELT DRIVEN AIR COMPRESSOR EQUIPPED WITH HALL VOLUME REGULATOR

the pipe, 38, to such an extent that the air will enter the auxiliary chamber, 8, through the passage, 11, at the same rate as it escapes through the leak, 9, thereby keeping constant the pressure in the reservoir, 8, which through pipe, 7, and the opening, 23, acts upon the cylindrical valve, 20. Under these conditions the pressure in the auxiliary chamber will be somewhat less than that in the main tank and in the passage, 40, leading from the cylinder, 18, to the main tank.

Owing to the low pressure thus created in the plunger, 22, the discharge valves will be kept open during part of the following stroke, and allow a certain amount of compressed air to re-enter the cylinder from the outlet passage, 40, and expand in the cylinder to intake pressure. During the remaining part of the suction stroke, the amount of fresh air drawn into the cylinder will exactly correspond to the consumption of compressed air at the time and the air pressure in the main tank remain constant.

A globe valve, 41, allows enough of the pressure air contained in the auxiliary tank to escape to the atmosphere so as to unload the compressor by hand if desired. A similar valve, 42, is opened by means of a speed regulator if the speed of the prime mover falls below a cer-

tain value and it is desired to unload the compressor in that case.

Figure 3 shows a series of indicator cards taken in a service test on an ordinary poppet valve air compressor with by-pass, equipped with the volume regulating device, represented in Fig. 1. The figures at the right of the upper diagram refer to the pounds pressure in the auxiliary reservoir.

APPLICATION TO COMPOUND AIR COMPRESSORS

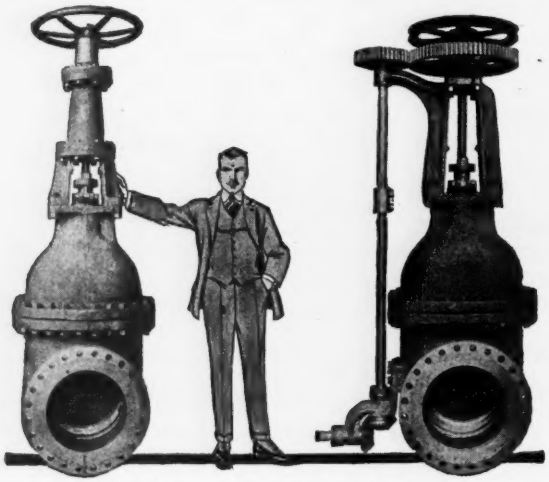
IN CASE of compound or multiple-stage air compressors, each stage has, as a rule, its own regulator.

Due to the fact that the different stages of multiple-stage air compressors may operate at different cutoffs, the present system of regulation is exceedingly flexible and the generally intricate problems arising in connection with the regulation of such compressors are easily solved.

Big Gate Valves for Superheated Steam

PERHAPS the largest steel gate valves for superheated steam yet installed in any of the immense power plants of New York are those recently built by the Nelson Valve Co., of Philadelphia, for the New York Edison Co.

That these valves are strictly in keeping with the proportions of this, one of the largest public service plants in the world, is best shown by the photograph in which the ordinary man appears but a dwarf when compared to the valves beside him.



LARGE STEEL GATE VALVE FOR SUPERHEATED STEAM

Seven of these valves of the 2 types shown were built and shipped by the Nelson Valve Co. in 50 days from the receipt of the order, a remarkable record when it is considered that new patterns had to be made throughout. Each valve, from top of stem, when valve is open, to bottom of body, stands 9 ft. 1 in. in height and the 2 types weigh 3600 and 3900 lb. respectively.

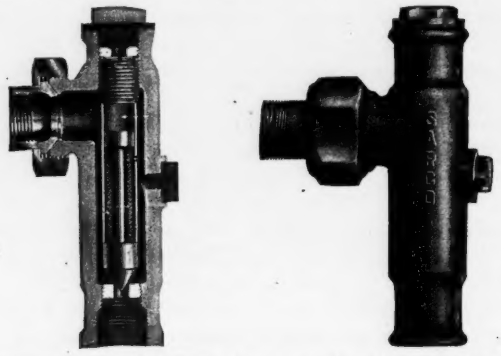
The valve shown at the left of the photograph is hand operated, though made with a large bushing just below the hand wheel, which may be removed for attachment of spur gears, if desired. The left-hand valve is fitted with spur gears, bevel gears and chain for chain operation. The New York Edison Co. will install this valve on a vertical pipe line and run the extension stem (to which is attached a bevel gear) through a wall for operating from another room. This valve can also be operated by chain, the chain wheel being attached directly to the valve stem. These valves will be used by the New York Edison Co. on header lines for 200 lb. pressure, 150 deg. superheat.

Regarding the details of construction, the Nelson Co. says: "The valves have steel body and bonnets, with seat and disc wings of forged monel metal and stem of rolled monel. Guides in both bonnets and body are machined, also wing lugs on the gate discs. Brackets are provided on the inside of the yoke to support the gland when repacking the stem, eye bolts at the top of the bonnet swing out of the way so that the valve may be repacked."

Both the steel and monel metal used in these valves have a tensile strength of over 65,000 lb. per sq. in., and the coefficients of expansion of the 2 metals are practically the same, an important point, since with the great changes in temperature where superheated steam is used, the expansion and contraction will cause a loosening of the seat rings, and other parts if this point is not taken into consideration and provided for.

The Sarco Vacuum Valve

THIS valve is a modification of the Sarco steam trap and has recently been developed for use on radiators in vacuum heating systems. It consists of a pipe body, which occupies little space and takes the place of a radiator elbow. In this body, a cartridge is inserted containing an easily expandable fluid which does not freeze at the lowest atmospheric temperature, operating a corrugated tube to the lower end of which is attached a piston which carries the valve heads.



EXTERIOR AND INTERIOR OF A SARCO VACUUM VALVE

As soon as water collects, the liquid within the cartridge contracts and the valve opens. The condensation which has collected is drawn out by the suction and immediately the steam comes into contact with the cartridge, there is an expansion and the valve closes, maintaining a perfect vacuum within the system. Once having set the valve, it works automatically and without noise. As there are no pockets formed, the valve is self-cleaning, and working upon the thermostatic principle, no difficulty is experienced with air binding.

This vacuum valve is the product of the Sarco Engineering Co., 116 Broad St., New York.

New Brown Resistance Thermometer

A NEW resistance thermometer just placed on the market by the Brown Instrument Co., of Philadelphia, Pa., is claimed to measure, with the greatest accuracy, temperatures ranging from 200 deg. below 0 to 1800 deg. F. above 0. This instrument is particularly well adapted for measuring low temperatures, which are out of the range of the thermo-electric pyrometer, and is useful for measuring the temperatures found in driers and ovens, in the overheated bearings of machinery, in the windings of electrical apparatus, in connection with refrigerating machinery and systems and in rooms which must be maintained at constant temperatures.

Figure 1 illustrates the Brown indicating instrument, which is connected by means of a 3-wire cable to bulbs located at various points around the plant and in order to determine the temperature at the point desired, it is necessary simply to turn the handle shown in the figure to the correspondng station number.

FIG. 1. THE BROWN ELECTRIC PYROMETER

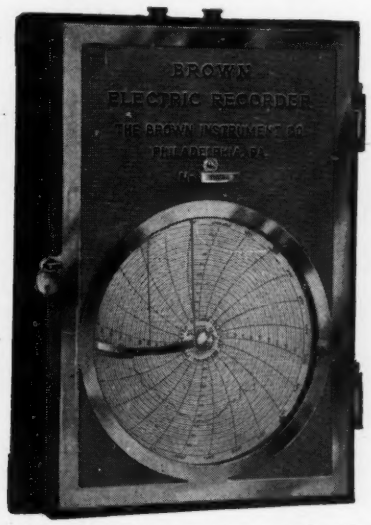


FIG. 2. THE BROWN ELECTRIC RECORDER

The instrument proper consists of metal bulbs containing resistance wire through which a current, supplied by dry cells or a storage battery or that taken from a 110 or 220-volt direct-current lighting circuit, is used, and operates on the elementary principle of change of temperature producing a change of resistance.

Chief among its advantages is the ability to read moderate temperatures from one central location and thereby avoiding the loss of time required in going from point to point to read individual thermometers and the fact that the bulbs are all of metal and therefore not liable of being broken, as is the case with glass instruments.

This instrument may be supplied in the recording form as shown in Fig. 2.

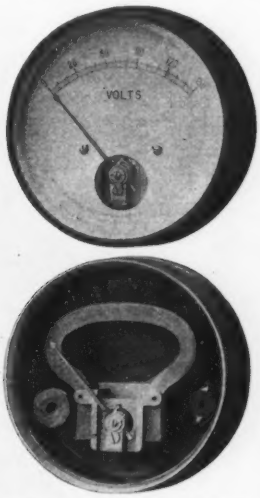
The indications of the instruments are guaranteed to be within 1 per cent.

New D. C. Switchboard Instruments

A NEW line of 5-in. direct-current ammeters and voltmeters, known as the type FW, has just made its appearance. These are indicating meters suitable for small, isolated plants, yachts, battery-charging panels, etc., where a high grade, low-price polarized instrument is required.

The meters operate on the D'Arsonval principle, having a moving coil and a permanent magnet. Being of the permanent-magnet type, they possess many points of superiority to the moving-iron type construction found in the usual lower priced meters.

The complete movement is mounted in the case as a unit. A unique feature is the arrangement of the moving element, which can be taken from the movement by simply removing 2 screws on the side of the pole-piece support. The entire moving element and bearings can then be lifted out as a unit and can be replaced in exact position. This makes it possible to repair the meter without disturbing the alinement of the magnetic circuit.



EXTERIOR AND INTERIOR OF TYPE FW 5-IN. D. C. SWITCHBOARD METER

Owing to the use of an aluminum pointer, a light counter weight is possible, resulting in a light weight of movement and small wear on the pivot jewels. The high torque, in proportion to the light weight, insures great accuracy, considering their size.

Although somewhat diminutive in size, these meters are designed along strictly scientific lines and possess a high grade of quality.

Their scales are 4 in. long, practically the same length as the scales of many of the 7-in. meters. The full length of the pointer shows on the dial, thus making the meter as easy to read as a clock. The movement is thoroughly damped to secure dead-beat readings. These meters are manufactured by the Westinghouse Electric & Mfg. Co.

The Clark Engine

AMONG the distinctive features of this newly developed engine the most important is the fact that both the cylinder and piston are given a reciprocating motion, and are connected to crankpins, 180 deg. apart on the shaft. The engine operates in the same manner as the slide valve engine, steam being let into the steam chest, formed with sleeves oppositely extended, and port pipes extending from opposite ends of the cylinder having their end portions arranged to slide in sleeves, pushes the piston and cylinder in opposite directions, which results in rotation of the driving shaft. These relative movements are continued throughout the operation.

The driving shaft has 3 cranks; the central crank is opposite in direction to the side cranks as seen in Fig. 3. The connecting rods are attached to these cranks, and the upper ends of the outside connecting rods are joined to short hangers attached to the lower cylinder head. The center connecting rod is connected to the crosshead and

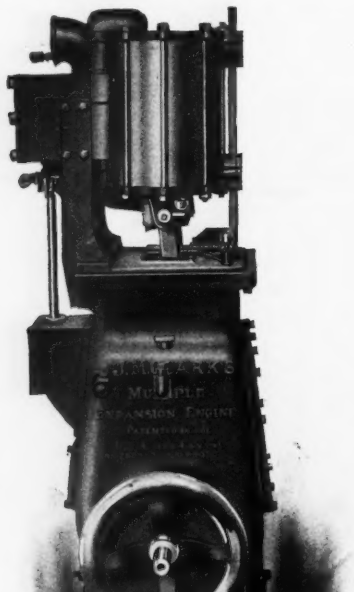


FIG. 1. CLARK MULTIPLE EXPANSION HIGH-SPEED ENGINE

piston, which balance by weight the cylinder and its moving parts. The power exerted by the piston is the same as that by the cylinder, and this perfect balance of both weight and power produces a smooth movement. For this reason, it is possible also to run this engine in any position, vertical, horizontal or at an angle, and the absence of vibration renders heavy and expensive foundations and bed plates unnecessary. Although these engines are rated at maximum speed of 900 to 1500 r.p.m., speed has on occasions been run up as high as 3500 r.p.m. without injury in any way to the engine.

It will be noted that, while the stroke of either the piston or the cylinder is equal to twice the radius of the crank circle, the relative motion of the piston and the cylinder is twice this amount; so that, with cutoff at ⅓ the stroke of the piston, the steam will expand 6 times, thus securing a multiple expansion feature similar to that of compound engines.

Advantages claimed for this engine are light weight, perfect balance, high speed, no thrust, small floor space, economy, simplicity and low cost. They are built in sizes from 15 to 55 hp., by J. M. Clark, Whitestone, L. I., N. Y.

FIG. 2. CYLINDER PARTS OF THE CLARK ENGINE

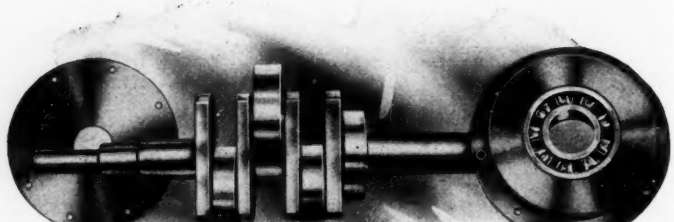


FIG. 3. CRANK SHAFT OF THE CLARK ENGINE

Test of Wheeler Turbo Air Pump

TO obtain a high vacuum in a condenser, it is necessary that the air be withdrawn at a pressure of a fraction of an inch of mercury, and a volume of 1000 to 10,000 cu. ft. per pound.

With a pump capable of this duty, there remain but 2 hindrances to the attainment of very high vacuums at the turbine exhaust. The first of these is the quantity of circulating water and its temperature. Assume the water is at 60 deg., then if a 29-in. vacuum is desired, corresponding to a steam temperature of 79 deg., it is evident that the water cannot take up heat when its temperature has gone above 79 deg., in theory, and in practice, above 70 or 75 deg., since some "heat head" is necessary to cause the transmission of heat.

The second hindrance to the attainment of extremely high vacuums is the loss in pressure between the turbine exhaust and the air pump suction, due to the resistance of the tubes, or in other words, the hydrodynamic loss. This may be reduced to a few tenths of an inch of mercury by the proper arrangement and spacing of tubes.

(Continued on page 757.)

These tables contain data especially worked out or carefully selected that are vital to your work. You may need them at any time and should preserve them. A handy, serviceable, loose-leaf cover in which these tables fit exactly, will be sent you for 30 cents in currency or stamps.

PRACTICAL ENGINEER

Equipment of Producer Gas Plant

2 110-hp. producer units.

2 13 by 12-in., 3-cylinder vertical engines, 89 b.hp. each, 265 r.p.m.

2 direct-driven, 13 by 15-in., triplex pumps, 5 to 1 gear, 44 r.p.m., 1,640,000 gal. each per 24 hr.

Coal used, anthracite pea, $5.10 per long ton.

The cost of the plant was as follows:

Building and property	$38,750
Producers and engines complete, including auxiliaries	13,000
Pumps complete	7,250
Piping, air chambers, etc.	4,500
Total	$63,500
Cost of plant per brake horsepower	392
Cost of plant per 1,000,000 gal. capacity per 24 hr.	19,250

Equipment of Steam Plant

3 100-hp., h.r.t. boilers.

2 horizontal, cross-compound condensing Corliss engines, 18 and 32 by 30 in., 55 to 60 r.p.m.

2 pump ends, direct-driven, 10 by 30 in., capacity 3,000,000 gal. per 24 hr. at 150 lb. pressure.

Coal used, high grade bituminous, $4.40 per long ton.

The cost of this plant was as follows:

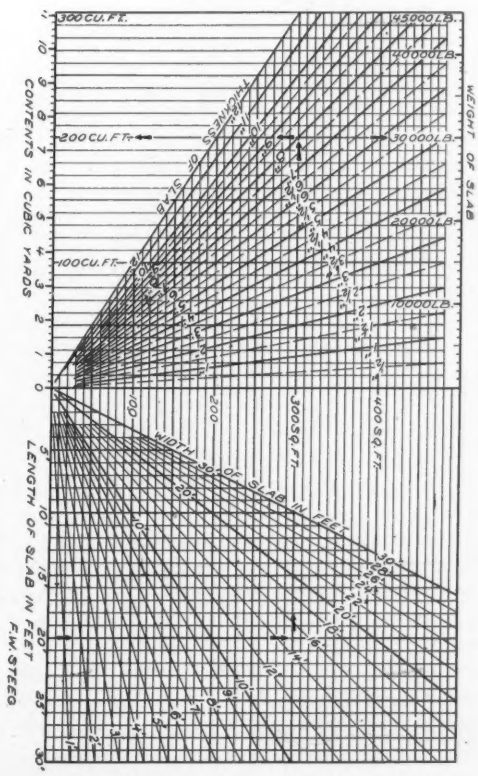
Building and land	$37,875
Boilers, engines, piping and auxiliaries	39,850
Total	$77,725
Cost of plant per brake horsepower, allowing 10 per cent for engine friction	190
Cost of plant per 1,000,000 gal. capacity per 24 hr.	12,100

PRACTICAL ENGINEER

DIMENSIONS AND WEIGHTS OF INSULATED CABLES FOR 600 VOLTS.

Circular Mills	Double Braided Cable: Rubber Wall in 64ths of an In.	Double Braided Cable: Approx. Outside Dia. in 64ths of an In.	Double Braided Cable: Approx. Net Wt. per 1000 Ft. Lb.	Double Braided Cable: Underwriters Voltage Test	Lead Covered Cable: Wall Thickness in 64ths of an Inch: Rub'r	Lead Covered Cable: Wall Thickness in 64ths of an Inch: Lead	Lead Covered Cable: Approx. Outside Dia. in 64ths of an In.	Lead Covered Cable: Approx. Net Wt. per 1000 Ft. Lb.	Lead Covered Cable: Underwriters Voltage Test
2,000,000	8	134	7315	3500	8	8	142	11,100	3500
1,750,000	8	128	6445	3500	8	8	136	10,065	3500
1,500,000	8	120	5600	3500	8	7	126	8,525	3500
1,250,000	8	110	4665	3500	8	7	116	7,360	3500
1,000,000	7	100	3785	3500	7	6	105	5,860	3500
950,000	7	98	3565	3500	7	6	102	5,580	3500
900,000	7	96	3370	3500	7	6	100	5,350	3500
850,000	7	94	3245	3500	7	6	99	5,210	3500
800,000	7	90	3030	3500	7	6	96	4,940	3500
750,000	7	88	2845	3500	7	6	94	4,715	3500
700,000	7	86	2690	3500	7	6	92	4,515	3500
650,000	7	84	2506	3500	7	6	90	4,300	3500
600,000	7	82	2355	3500	7	6	88	4,100	3500
550,000	7	80	2200	3500	7	6	86	3,910	3500
500,000	6	74	1955	3000	6	5	78	3,240	3000
450,000	6	70	1760	3000	6	5	74	2,985	3000
400,000	6	68	1590	3000	6	5	71	2,760	3000
350,000	6	64	1410	3000	6	5	68	2,530	3000
300,000	6	60	1230	3000	6	5	65	2,300	3000
250,000	6	58	1065	3000	6	5	62	2,075	3000

PRACTICAL ENGINEER



CONTENTS OF CONCRETE SLABS

DIMENSIONS AND WEIGHTS OF INSULATED CABLES FOR 600 VOLTS.

Size B & S Gage	Single Braided Stranded Conductors				Lead Covered Stranded Conductors				
	Wall in 64ths of an In.	Approx. Outside Dia. in 64ths of an In.	Approx. Net Wt. per 1000 Ft. Lb.	Underwriters Voltage Test	Wall Thickness in 64ths of an Inch		Approx. Outside Dia. in 64ths of an In.	Approx. Net Wt. per 1000 Ft. Lb.	Underwriter Voltage Test
					Rubber	Lead			
0000	5	50	855	2500	5	4	54	1575	2500
000	5	46	700	2500	5	4	50	1360	2500
00	5	42	575	2500	5	4	47	1200	2500
0	5	40	480	2500	5	4	44	1055	2500
1	5	35	375	2500	5	4	41	925	2500
2	4	31	300	2000	4	4	37	775	2000
3	4	29	250	2000	4	4	35	710	2000
4	4	27	200	2000	4	4	33	635	2000
5	4	26	170	2000	4	4	32	595	2000
6	4	24	141	2000	4	4	30	535	2000
8	3	19	93	1500	3	4	26	425	1500
9	3	18	78	1500					
10	3	17	67	1500					
12	3	16	54	1500					
14	3	14	43	1500					
16	2	10	23	1500					
	Solid Conductors				Solid Conductors				
1	5	33	360	2500	5	4	39	890	2500
2	4	29	280	2000	4	4	35	755	2000
3	4	27	225	2000	4	4	33	665	2000
4	4	25	185	2000	4	4	31	590	2000
5	4	24	156	2000	4	4	30	550	2000
6	4	23	133	2000	4	4	29	510	2000
8	3	18	86	1500	3	4	25	405	1500
9	3	17	73	1500					
10	3	16	62	1500	3	4	23	350	1500
12	3	15	48	1500	3	3	20	240	1500
14	3	12	34	1500	3	3	18	205	1500
16	2	10	22	1500	2	3	16	170	1500
18	2	9	18	1500					

MATERIALS FOR CONCRETE.

Proportions of Mixture			Material for One Cubic Yard Concrete									
			Gravel ¼ in and under			Stone 1 in. and under, dust screened out.			Stone 2½ in. and under dust screened out			
Cem't	Sand	Stone	Cement Bbls.	Sand Yds.	Stone Yds.	Cem't Bbls.	Sand Yds.	Stone Yds.	Cem't Bbls.	Sand Yds.	Stone Yds.
1	2	3	1.54	0.47	0.73	1.70	0.52	0.77	1.73	0.53	0.79
1	2	4	1.34	0.41	0.81	1.46	0.44	0.89	1.48	0.45	0.90
1	2	5	1.17	0.36	0.80	1.27	0.39	0.97	1.29	0.39	0.98
1	2½	4	1.24	0.47	0.75	1.35	0.52	0.82	1.38	0.53	0.84
1	2½	5	1.10	0.42	0.83	1.19	0.46	0.91	1.21	0.46	0.92
1	2½	6	0.98	0.37	0.89	1.07	0.41	0.97	1.07	0.41	0.98
1	3	5	1.03	0.47	0.78	1.11	0.51	0.85	1.14	0.52	0.87
1	3	6	0.92	0.42	0.84	1.01	0.46	0.92	1.02	0.47	0.93
1	3	7	0.84	0.38	0.89	0.91	0.42	0.97	0.92	0.42	0.98
1	4	6	0.83	0.51	0.77	0.90	0.55	0.82	0.92	0.56	0.84
1	4	7	0.77	0.47	0.81	0.83	0.51	0.89	0.84	0.51	0.90
1	4	8	0.71	0.43	0.86	0.77	0.47	0.93	0.78	0.48	0.95
1	4	9	0.65	0.40	0.89	0.71	0.43	0.97	0.73	0.46	1.01

COST OF PUMPING ONE MILLION GALLONS 100 FEET HIGH

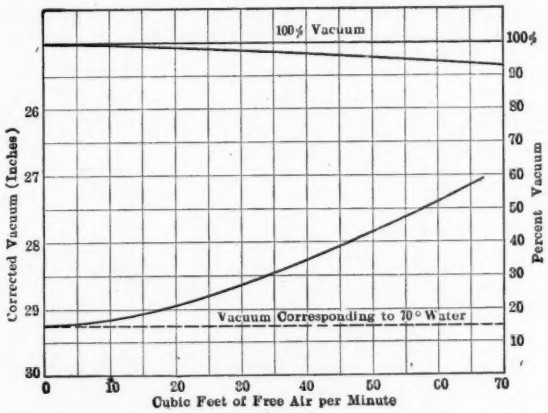
Unit per Million Gallons Actually Pumped 100 ft. High		1908		1909		1910		1911		1912	
		Gas	Steam	Gas	Steam	Gas	Steam	Gas	Steam	Gas	Steam
Fixed Charges:											
Management	1	$0.995	$0.491	$0.589	$0.482	$0.318	$0.415	$0.301	$0.407	$0.293	$0.376
Superintendence	2	4.590	2.265	2.715	2.215	1.465	1.908	1.381	1.875	1.345	1.741
Depreciation	3	8.440	4.985	5.000	4.790	2.695	4.120	2.552	4.050	2.480	3.755
Sinking Fund	4	5.200	3.180	3.080	3.120	1.658	2.685	1.569	2.645	1.522	2.498
Interest	5	20.400	15.970	12.080	15.620	6.500	13.440	6.150	13.230	5.980	12.270
Insurance	6	0.379	0.615	0.224	0.602	0.121	0.519	0.114	0.509	0.111	0.473
Taxes	7	1.313	0.803	0.787	0.788	0.418	0.693	0.396	0.666	0.400	0.618
Total cost per annum	8	$41.317	$28.219	$24.475	$27.617	$13.175	$23.780	$12.463	$23.382	$12.131	$21.731
Operating charges:											
Fuel	9	$2.615	$2.410	$1.441	$2.698	$1.291	$2.425	$1.505	$2.510	$1.860	$2.305
Oil, waste and packing	10	0.775	0.126	0.439	0.115	0.366	0.076	0.232	0.126	0.208	0.106
Pumping-station wages	11	7.490	6.210	5.470	5.825	3.615	4.790	3.787	4.450	3.670	4.520
Machinery repairs and building	12	0.432	0.072	0.631	0.0095	0.461	0.146	0.256	0.327	0.431	0.315
Miscellaneous expenses	13	0.322	0.133	0.300	0.0735	0.157	0.048	0.188	0.088	0.285	0.103
Total cost per annum	14	$11.634	$8.951	$8.281	$8.721	$5.890	$7.435	$5.968	$7.501	$6.454	$7.349
Total of the operating and fixed charges	15	$52.951	$37.170	$32.756	$36.338	$19.065	$31.265	$18.431	$30.883	$18.585	$29.080
	16	Ave. cost of pumping 1 million gal. 100 feet high—gas									$26.36
	17	Ave. cost of pumping 1 million gal. 100 feet high—steam									32.95

FIXED CHARGES

	Gas Plant $ 200	Steam Plant $ 200
Management	920	920
Depreciation	1,694	1,987
Sinking fund	1,043	1,297
Interest	4,095	6,491
Insurance	76	250
Taxes	263	327
Total	$8,291	$11,472

It is evident from the foregoing that if we use sufficient cooling water in proportion to the steam to give a rise in temperature of the water of only 10 or 15 deg., it is possible to obtain a vacuum of 29 in. with 60 deg. inlet cooling water, provided the air pump will maintain a vacuum 0.1 to 0.2 higher, that is, 29.1 to 29.2 in.

This is done with modern types of rotary air pumps, even with 70 deg. water, as shown by the test of a Wheeler turbo air pump, reproduced in the chart. The conditions of the test were a water temperature of 70 deg., the pump maintained a vacuum of 100 per cent of the theoretical with closed air suction and with 10 cu. ft. of free air per minute load, the pump maintained a vacuum of 29.1 in., corresponding to 99.7 per cent of



TEST CURVES, SHOWING AIR CAPACITY AND VACUUM WITH 70-DEG. WATER

the theoretical. With 18 cu. ft. of free air load, the pump maintained a vacuum of 29 in. The vacuums with increasing load up to 65 cu. ft. of free air per minute, are given by the curve.

The pump consists of a high-speed small impeller, a ring of diffusion channels and a casing. The impeller discharges water in separate streams into the fixed compression or diffusion ring, whose blades cut the jets into a large number of plugs or layers, which close the entire section of the channels and force the entrapped air out against atmospheric pressure. Air is admitted to the center of the casing by a large nozzle on the bearing side of the pump and is drawn into the diffusor all around the impeller. This gives a large capacity for a small diameter impeller, which rotates at high speed, suitable for direct connected turbine drive. The pump is built by the Wheeler Condenser & Engineering Co., Cartaret, N. J.

Book Reviews

THE THEORY OF HEAT ENGINES. By William Inchley. New York, 1913; 480 pages, 6 by 9 in., with diagrams and index. Stiff cloth binding, price $2.25.

It is difficult to deal with the subject of thermodynamics without the use of rather intricate mathematical formulas, and this book is not one which will be satisfactory or helpful to the many who cannot readily deal with algebraic equations, transformations and the use of trigonometric functions and the processes of calculus. As stated in the preface, it is written mainly for engineering students, covering the ground required for university examinations in the theory of heat engines, and is a useful book for one who desires a thorough knowledge of this subject. It covers many points not usually treated in books of this character, as will be shown by a glance at the chapter headings.

Chapter 1, deals with the Thermodynamics and Properties of Gases; Chapter 2 with Hot Air Engines; Chapter 3, Properties of Steam; Chapter 4, Theory of the Steam Engine; Chapter 5, the same; Chapter 6, Compound Expansion; Chapter 7, Mechanical Refrigeration; Chapter 8, Flow of Steam Through Orifices and Nozzles; Chapter 9, Theory of the Steam Turbine; Chapter 10, Theory of Air Compressors and Motors; Chapter 11, Combustion; Chapter 12, Heat Transmission; Chapter 13, Theory of the Gas Engine; Chapter 14, Theory of the Internal Combustion Engine; Chapter 15, Theory of the Oil Engine; Chapter 16, Testing Internal Combustion Engines; Chapter 17, Steam Engine and Boiler Trials; Chapter 18, Valves, Diagrams and Valve Gears; Chapter 19, Twisting Moment Diagrams; Chapter 20, Balancing; Chapter 21, Governors.

Numerous examples are given throughout the book, and the answers are to be found in the appendix; also sufficient tables to enable the working of the problems conveniently. The student who is familiar with mathematics of the branches mentioned will find the book interesting and profitable.

ELEMENTARY MANUAL OF THE STEAM ENGINE. By E. V. Lallier, New York, 1913; 260 pages, 5 by 8 in.; fully illustrated, in cloth cover; $2 net.

As stated by the author, the object of the book is to present the fundamental principles of the use of steam and steam engines in an elementary manner, thus giving a foundation and guide to further study. For this purpose it is excellent, as it is free from mathematics and takes up the fundamentals of the steam engine and its allied machinery in a way that can be understood by one who has had no experience with such machines. It is suitable for the high-school student, or for the man who is just beginning his career in the boiler and engine room. The subjects treated are Reciprocating Steam Engines and Their Details, Including Governors, Action of the Slide Valve, The Indicator, Measurement of Heat, and Measurement of Power; Boilers, including the horsepower and details of construction and accessories, Pumps and Injectors, Corliss Engines, both simple and compound; The Use of a Condenser; Pipes and Fittings, showing the flow of the steam, use of valves and coverings; Rotary Engines, including turbines and other types; Internal Combustion Engines; Lubrication, including the use of oils and greases.

HOW TO BUILD UP FURNACE EFFICIENCY. By Joseph W. Hays. Chicago, 1914; 126 pages, 5 by 7 in., with illustrations. Paper cover, price $1.

This is a somewhat popular, but nevertheless instructive treatment intended for the owner and manager as well as the operator of steam boilers, showing how fuel is wasted, and how to stop the waste. It explains the causes of loss, where to look for losses, what the indications of the draft gage, the flue gas thermometer and the carbon dioxide recorder mean; and it outlines a method,

after we have found the losses and stopped them, of inaugurating a program which will keep the waste stopped. The book is largely a record of experience addressed to the manager of a plant, showing him what others have done and what he may do. It is just as readable and understandable for the chief engineer as for the manager, and if it is read, understood and put into practice will be well worth the price of admission.

A STANDARD SANITARY PLUMBING CODE. By Scotland G. Highland, Secretary and General Superintendent of the Clarksburg, W. Va., Water Works and Sewerage systems, a practical, working manual for sanitary engineers and plumbers, dealing with safe and sanitary methods of supplying water to buildings and dwellings, of removing water and wastes therefrom, and with the details of practical plumbing and drainage.

The Code plainly informs plumbers how installations should be made for the protection of the property and health of the occupants, thus putting into their hands knowledge of safe, sanitary and scientific plumbing not easily available. A copy of this valuable work may be obtained upon application to the author.

Catalog Notes

A RECENT General Electric Co. Bulletin, No. 48,010, is devoted to the use of electricity in the shoe and leather industry. This is a bulletin of 32 pages, which takes up, in considerable detail, the subject of electric drive in shoe factories and tanneries, and contains numerous illustrations of installations in various factories of prominence in the East.

LINK-BELT CO., of Chicago, is sending out Section A of Catalog No. 110, containing complete information on detachable Link-Belt, with illustrations made from photographs not retouched to change their appearance.

A NEW CATALOG devoted to "Columbia" recording thermometers has just been received. This catalog is comprehensive, telling in an interesting way the mission of the recording thermometer in the modern industrial field—its value to the engineer in helping him to obtain a maximum amount of power from a minimum coal consumption. Illustrations show the numerous types of "Columbia" recording thermometers. Among new features outlined are the removable, adjustable and compensated recording pen arm, the new patented fume and moisture-proof insulation for the steel connecting tubing of the "Columbia" and the "Day and Night" border chart.

A copy of the catalog may be had by writing to The Schaeffer & Budenberg Mfg. Co., 963 Kent Ave, Brooklyn, N. Y.

GENERAL ELECTRIC Bulletins Nos. 43,400, 43,401 and 43,402 take up the subjects of modern lighting in woodworking plants, the clothing industry, machine shops and metal working plants. The advantages of this system of lighting are now generally known. The bulletins describe the various lamps adapted to this service and give suggestions as to the size and style of the units best suited to the greatest all-round efficiency. There are numerous illustrations which in themselves offer suggestions to those contemplating this system of lighting.

A CIRCULAR illustrating "Alligator" steel belt lacing is being issued by Flexible Steel Lacing Co., 522 S. Clinton St., Chicago.

INTERNALLY FIRED Scotch Marine Boilers with Water Backs is the subject of a pamphlet just issued by Murray Iron Works Co., Burlington, Iowa.

L. J. WING MFG. CO., 352 West 13th St., New York, recently issued Bulletin 17, superseding Bulletin 7 and relating to air handling and power plant machinery.

BULLETIN 301A from Pawling & Harnischfeger Co., Milwaukee, on The Application of the Electric Hoist, shows installations of a small hoist in industrial plants.

AIR COMPRESSORS and vacuum pumps manufactured by Mesta Machine Co., Pittsburgh, Pa., are described and illustrated in Bulletin N, lately received from the company.

HIGH-VOLTAGE porcelain insulators are listed in Westinghouse Catalog Section DS845, for transmission lines up to 110,000 v., being supplied also for use on any commercial voltage. The same section illustrates various styles of glass pin-type insulators.

CRANE CO.'S Circular No. 108 relates to "Klingerit" and C. C. Packings. Circular No. 64B, describing and illustrating Crane automatic stop-check valves, has also been received.

These circulars may be obtained by addressing the company at 836 S. Michigan Ave., Chicago, Ill.

LIFTING THE Quebec Bridge is described in a pamphlet which reprints an article from The Engineering Magazine. This pamphlet is published by the company designing and supplying the electrical apparatus, with the exception of the motors,—The Electric Controller & Mfg. Co., Cleveland, O.

FORT WAYNE Electric Works of General Electric Co. has issued Bulletin No. 46,203, describing and illustrating its Type K5 single-phase watthour meter, in the design of which it has been the endeavor to combine simplicity of mechanical construction with a high degree of accuracy and reliability. The meter is compact, light in weight and occupies little space.

AMONG RECENT PUBLICATIONS dealing with the different lines of apparatus manufactured by the Westinghouse Electric & Mfg. Co. are the following:

Leaflet 3512-A describes Westinghouse electric auto starters for squirrel cage motors. The construction of this device is fully described and illustrated, as is also the overload relay with which it is equipped.

Leaflet 2364 describes Westinghouse Electric direct-current Type K crane motors. These motors are designed for severe intermittent varying speed service where high starting torque is required, such as cranes, hoists, coke charging machines, etc. Complete and detailed views of the motor are given and the more important features of construction described.

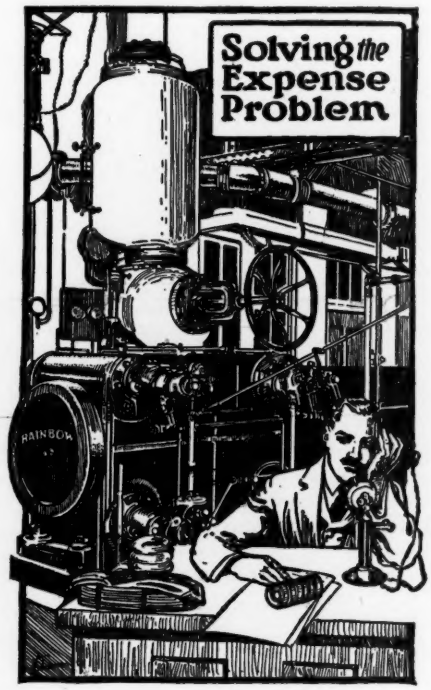
Folder 4172 describes the Westinghouse bell ringing transformer and shows how it should be installed. On the back page is shown a comparison of the old method of using batteries and how they are subject to breakage, with the new way with the transformers, giving an interesting comparison between the 2 methods.

A 2-YR. CALENDAR for June, 1914, to June, 1916, is being sent out by Wagner Electric Mfg. Co., of St. Louis, Mo.

RUBBER WHEELS and casters are described in Bulletin AC, from The George P. Clark Co., Windsor Locks, Conn.

THE WEIR turbine-driven rotary feed pump is described and illustrated in a recent publication of G. & J. Weir, Ltd., 52 Broadway, New York.

HEREWITH IS ILLUSTRATED the cover design of a new pamphlet on the subject of Rainbow packing, manufactured by Peerless Rubber Mfg. Co., 16 Warren



St., New York. Illustrations within show several styles of packings, also the development of the factory behind the "Rainbow family."

LINK-BELT CONVEYORS for newspapers, magazines, etc., are illustrated in Link-Belt Co.'s Book No. 95, which shows the conveyors in use in the press rooms of many periodicals. A copy of the pamphlet will be sent to anyone addressing the company at Chicago, Philadelphia or Indianapolis.

CHABELCO Steel Chain Belt Catalog No. 54, just off the press, comprises 32 pages, devoted to illustrating the different sizes of Chabelco, price lists, tables of dimensions of the various sizes and tables of sprocket wheels for these sizes to run on. The manufacturer is Chain Belt Co., Milwaukee, Wis.

THE FOLLOWING publications have recently been issued by the Westinghouse Electric & Mfg. Co.:

Ad Leaflet No. 103, which contains a description with illustrations of the cutout showing a young girl in a standing position representing the figure adopted by the Westinghouse Co., designated as Dorothy. This cutout, which is lithographed in 6 colors, can be used with a display of any heating device or fan. One arm is hinged so it can be moved to various positions. Window displays showing the cutout demonstrating electric fans and heating devices are also illustrated and described.

Descriptive Leaflet No. 3723, describing Baldwin-Westinghouse industrial locomotives, shows a number of installation views of this class of apparatus, and a description of the characteristics of the locomotives is also given.

GENERAL PRINCIPLES of Special Type B Playford stoker manufactured by Rosedale Foundry & Machine Co., Pittsburgh, Pa., are given in Bulletin B, with views of typical installations with Stirling, B. & W. boilers, etc. An illustration shows the method of inserting repair grate links in the stoker chain without removing the carrying grate bar rods, permitting repairs to be made in a few moments, without interfering with the operation of the stoker.

Trade Notes

AMONG RECENT installations reported by The Vilter Mfg. Co., Milwaukee, Wis., are the following: Wm. Franzen & Son., Inc., Milwaukee, Wis., a 16 by 36-in. Corliss engine with an air compressor; Cohen & Co., Chicago, Ill., a 15-ton refrigerating machine; E. S. Perkins, Merchantville, N. J., a 20-ton can ice-making plant; Fisher Artificial Ice & Cold Storage Co., Dubuque, Ia., machinery and equipment for a 50-ton can ice-making plant; Columbus Brewing & Malting Co., Columbus, Nebr., a 35-ton refrigerating machine and high pressure side; Crescent Creamery Co, Los Angeles, Cal., a 50-ton refrigerating machine with 2 ice tanks and equipment; Chanute Light & Ice Co., Chanute, Kan., 4400 ft. of 2-in. wrought iron piping; Williams Ice Cream Co., Scranton, Pa., a 40-ton refrigerating plant; The Cia Empacadora de Tampico, Tampico, Mexico, a 10-ton can ice-making tank and equipment; Manitoba Cold Storage Co., Winnipeg, Man., Canada, machinery and piping for a 300-ton refrigerating plant; E. A. Park, Blackville, West Va., a 10-ton can ice-making plant; Keokuk Pure Ice Co., Keokuk, Ia., a 40-ton refrigerating plant; Home Ice & Cold Storage Co., Long Beach, Cal., a 25-ton ice-making plant; Augustin Portillo, Santa Cruz, De Tenerife, Canary Islands, Spain, machinery for a 10-ton can ice-making plant; University of Texas, Austin, Tex., a 5-ton refrigerating plant; Greeley Kolts, Los Angeles, Cal., 3260 ft. of 1¼-in. extra heavy wrought iron piping, one 12-in. diameter accumulator, 20-ton reboiler, and one oil separator; Class & Nachod Brewing Co., Philadelphia, Pa., a 150-ton refrigerating plant.

IN CONNECTION WITH the question of whether the use of graphite to free boilers from scale is effective or not, a report made by the Wahl-Henius Institute of Fermentology, of Chicago, is of interest. After a laboratory analysis of Mexican boiler graphite and a study of its effect in boilers in various plants the report of the institute says: "Based upon the result of our laboratory tests and those obtained in actual practice, we consider Mexican Boiler Graphite a very effective article for preventing the formation of boiler scale, as well as for the removal of old scale. However, when the feed water reacts acid or contains salts that exercise a corroding effect on iron, soda ash or caustic soda should be

employed in conjunction with the usual quantity of graphite, so as to neutralize the action of these corroding substances. Boiler graphite is free from any ingredient that could impart a foreign taste or odor to the steam generated from water to which it is added."

FOR THOSE WHO have occasion to use a roof flagpole, the inconvenience of getting at it when there is necessity for repainting or other repairs is entirely evident. To overcome these difficulties, Elmer E. Carr, 231 Insurance Exchange Bldg., Chicago, has designed a tilting flagpole, which is carried in a castiron base, swung on a trunnion and counter-balanced so that it can easily be lowered to a horizontal position on the roof for inspection or repairs, or can be laid horizontally over the front of the building and equipped with flag for street decoration or advertising. When in an upright position, it is securely locked between the supporting brackets by a bolt, as well as being held in position by the counter-balance.

On the buildings of electric light companies and on power plants, the pole has been equipped with electric lights, and thus used as an attractive night display. The fact that it can be tilted to the horizontal position for renewal of lamps and care of the electric wiring, makes it particularly available for such purpose.

WESTINGHOUSE Electric & Mfg. Co. reports the receipt of the following among recent orders: Charleston & Interurban Railway Co., Charleston, W. Va., 1 300-kw., 600-v., 3-phase, 60-cycle, 1200-r.p.m., rotary converter, 3 110-kva., 60-cycle OISC transformers, 6600 v. high tension to rotary and 1 switchboard; Atlantic Shore Railway Co., Kennebunk, Maine, 1 300-kw., 600-v., 3-phase, 60-cycle, 1200-r.p.m. rotary converter; Benton Harbor & St. Joe Railway & Light Co., Benton Harbor, Mich., 1 300-kw., 600-v., d.c., 3-phase, 60-cycle, 1200-r.p.m. rotary converter; United Gas & Electric Engr. Corp., Baltimore, Md., 3 1000-kw., 600-v., 6-phase, 60-cycle, 600-r.p.m. commutating pole rotary converters; Pacific Gas & Electric Co, San Francisco, Cal., 1 1000-kw., 650-v., 6-phase, 60-cycle, 600-r.p.m. rotary converter; Jamestown, Westfield & Northwestern Railway Co., Jamestown, N. Y., 1 complete portable substation consisting of 1 500-kw., 600-v., 6-phase, 25-cycle, 750-r.p.m. rotary converter, 1 550-kva., 3-phase, 25-cycle, 16,500-v. to rotary voltage OISC outdoor type transformer, 1 2-panel switchboard to control the above, and one substation car complete; St. Paul Southern Electric Railway Co., St. Paul, Minn., 1 300-kw., 600-v., 3-phase, 60-cycle, 1200-r.p.m., rotary converter and 3 100-kva., single-phase, 60-cycle, 13,000-v. to rotary voltage OISC transformer and 1 switchboard; Philadelphia Rapid Transit Co., Philadelphia, 2 3000-kw., 600-v., 6-phase, 25-cycle, 250-r.p.m. rotary converter and 6 1100-kva., single-phase, 25-cycle, 13,200-v. rotary voltage air blast transformers; Northern Texas Traction Co., Stone & Webster Engineering Corp., 1 1000-kw., 600-v., 6-phase, 25-cycle, 750-r.p.m. commutating pole rotary converter; Moir Hotel Co., Chicago, Ill., 1 200-kw., 250-125-v., 3-wire, 150-r.p.m. type Q generator and 2 400-kw., 250-125-v., 3-wire, 150-r.p.m. type Q generators; Harrisburg Foundry & Machine Works, Hotel Raleigh, Washington, D C., 1 125-kw., 250-125-v., 3-wire, 250-r.p.m. type Q generator, and 1 200-r.p.m., 250-125-v., 3-wire type Q generator.

PRACTICAL ENGINEER

Trade-mark, Reg. U. S. Pat. Off.

SEMI-MONTHLY

PUBLISHED ON THE FIRST AND FIFTEENTH OF EACH MONTH.

Subscription price in advance in the United States, Mexico or united possessions, $1.00 a year.

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Front cover, $150.00 per issue.

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Stipped plates used, but no heavy, black and white plates.

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Classified Rates

Per line, 30 cents each insertion.

Advertisements in this section are inserted under regular headings.

No display type allowed, but the first three words may be set in capital letters.

About nine words make a line. Minimum space sold, two lines.

Under classification "Position Wanted," advertisements not exceeding four lines will be inserted once for subscribers free of charge.

All copy should be received at Chicago office 18 days before date of publication.

Circulation of this issue, 23,500.

Technical Publishing Co.
537 S. Dearborn Street
Chicago

Position Wanted

POSITION WANTED—As engineer and fireman in a small plant, or a fireman or oiler in large plant. Have had experience with small steam engine and heating. Age 33. Address Anton Schall, St. Francis, Wis. 7-15-1

POSITION WANTED—By young man 24 years old with an Electric Construction Co. Holds I. C. S. diploma. Good workman. Best references Address Box 352, Practical Engineer. 7-15-1

POSITION WANTED—Master Mechanic, Chief Engineer and Efficiency Engineer with 10 years of Practical and Technical experience in Factory, Electric Light and R. R. Power Plants. Age 30. Strictly Temperate. Married. Chicago license. Can furnish best of reference. Open for engagement. Indiana preferred. Address Box 354, Practical Engineer. 7-15-1

AS MASTER MECHANIC of mines, or industrial plant; would also consider a job on construction or repair work of any kind; all-around mechanic, electricity, compressed air, steam and gas engines; expert on gasoline locomotives for mines; master mechanic for one company nine years; references; age 35; married. W. F. Shutt, Lookout Mountain, Tenn. 7-15-1

POSITION WANTED—As Electrician with an Architectural Contractor. Three years' experience on house-wiring for self. Strictly sober. Age 25. Can furnish reference. Middle West or West preferred. Write to F. T. C., 801 Shelby St., Falmouth, Ky. 7-15-1

POSITION WANTED—By initial and progressive steam and electrical engineer in Chicago or the Middle West. Age 35. Gilt edge references as to character and ability. Address Box 353, Practical Engineer. 7-15-1

POSITION WANTED—As Chief Engineer or Superintendent of Light or Power Plant. Employed 10 years as Chief Engineer in Light and Power Plant. References. Address Box 355, Practical Engineer. 7-15-1

POSITION WANTED—By engineer with 15 years' experience operating steam, electrical and refrigerating machinery. Sober, careful and practical man. Address Box 356, Practical Engineer. 7-15-1

Wanted

WANTED—ALL STEAM USERS to have clean boilers without using compounds or chemicals in any form. Write "Otis," No. 317 Norfolk Ave., Buffalo, N. Y. tf.

WANTED—Secretary of local Engineers' Association to write at once in regard to a very interesting proposition. Address Practical Engineer, Circulation Department.

WANTED—A small ice-making and refrigerating plant with a daily capacity of about 10 to 15 tons is wanted by a subscriber. A second-hand plant preferred. Give full particulars. Address, Box 341, Practical Engineer. tf.

WANTED—Every local Engineers' Association to have an assortment of valuable power-plant books—Secretary, write at once for full particulars Address, Dept. C, Practical Engineer, Chicago.

IF YOU ARE a night engineer, spend a few hours each day taking subscriptions for Practical Engineer. You will be paid well. Write Subscription Dept. They will start you in at once.

PRACTICAL MACHINIST and Engineer will invest $1000 to $1500 in established Machine Shop, Power Plant or Ice Plant as working partner. Address Box 357, Practical Engineer. 7-15-1

WANTED—A few hustlers to take orders for Zinco Soot Destroyer. Quick Sale. No competition. Good proposition. New York Supply Exchange, Ford Bldg., Detroit, Mich. tf.

Help Wanted

WANTED—An additional subscription solicitor wanted to cover towns in the State of Oklahoma. Excellent chance to earn extra money. Write to Subscription Department. tf.

For Sale

BOILERS—Two 250-hp. Babcock & Wilcox water-tube boilers, insurance certificate 160-lb. steam pressure, each $1000. Two 220-hp. Heine water-tube boilers, insurance certificate 150-lb. steam pressure, each $900. Engine: One 28x48 Hamilton Corliss heavy duty tangye frame engine, $1500. Duzets & Son, 50 Church St., New York. tf.

FOR SALE—550-volt, 60-cycle, 3-phase alternating current motors, complete with starting boxes. 1 50hp., $310; 1 30-hp., $216. 110-volt d.c. motors: 1 10-hp., $150; 1 3-hp., $72. All cash, 30 days. Parks & Woolson Machine Co., Springfield, Vermont. 7-15-4

TRAVELING CRANE—Wooden—For Sale Cheap. 15-ton capacity, 65-ft. span, suited for either motor or wire rope drive. Write Box 346, Practical Engineer. 4-15-6

CARR VENTILATED FURNACE ARCH for all types of boilers and furnaces, gives 100 to 400 per cent greater service than any other kind. Write for information, giving number and kind of boilers and furnaces. Elmer E. Carr, 231 Insurance Exchange Bldg., Chicago, Ill. 6-1-4

FOR SALE—At a Bargain. New 5 by 6, 4-cylinder, governor-controlled engine, fully equipped with carburetor magneto. Will sell for much less than cost. Fred Hanson, 570 Prior Ave., St. Paul, Minn. tf.

Patents and Patent Attorneys

PATENT YOUR INVENTION. Send sketch for free expert search and report as to patentability. Books on inventions and patents, and book of references from congressmen, manufacturers, bankers and inventors sent free. John S. Duffie & Co., 612 F St., N. W., Washington, D. C. tf.

PATENTS—C. L. Parker, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the invention. Handbook for inventors sent upon request. 186 McGill Bldg., Washington, D. C. tf.

PATENTS THAT PROTECT AND PAY. Advice and books free. Highest references. Best results. Promptness assured. Send sketch or model for free search. Watson E. Coleman, Patent Lawyer, 624 F St., Washington, D. C. tf.

PATENTS—H. W. T. Jenner, Patent Attorney and Mechanical Expert, 606 F St., Washington, D. C. Established 1883. I make a free examination and report if a patent can be had, and the exact cost. Send for full information. tf.

OFFICIAL DRAWINGS FREE. Patents procured or fee returned. Expert services. Send sketch for Free search. The Patent Exchange, Garban Bldg. Washington, D. C. tf.

FOR HONEST advice and real patent at Low Cost, consult John O Seifert. Patent Attorney, 50 Church St., New York. 5-15-6

PATENTABLE IDEAS WANTED—Send for 3 free books. R. B. Owen, 28 Owen Bldg., Washington, D. C. tf.

Educational and Instruction

ENGINEERS' POCKET MANUAL, 175 pages, edited by University of Tennessee. will be mailed every subscriber sending in NEW subscriptions (not your own) to Practical Engineer. Gilt edges; bound in leather.

Miscellaneous

WE GUARANTEE our device will remove scale, mud, and keep a boiler from foaming without the use of compound; to prove this we will let you try one 30 days without cost. Before buying any machine write for booklet and compare ours with other makes and see which is best. Lincoln Boiler Cleaner Co., Lincoln, Ill. 7-15-4

ENGINEERS—DO YOU WANT to utilize your exhaust steam for heating or drying purposes, without back pressure on your engine? If so, address Monash Engineering Co., 1413 W. Jackson Blvd., Chicago, Ill. tf.

MAKE MONEY on the side. Here's your chance to work out some money for yourself. Get subscriptions for Practical Engineer. It pays well. Just drop a line to the Subscription Dept. They will tell you. tf.

Sparks From The Advertising Pages

In many of the other "Sparks" pages we have been giving reasons why you should read advertisements. In this one we shall let an advertiser tell why sometimes you do not get the courtesy of a reply from a manufacturer whose advertisement you have read.

This letter is an interesting one and may strike home to you.

Practical Engineer, Chicago, Ill.

Gentlemen:—"We have been experiencing, in the past few months, a difficulty which we believe you could remedy by directing the attention of your readers to the need of more care in answering advertisements.

"We are prompted to write you in this way because we have had quite a few coupons sent in response to advertisements which have not enabled us to comply with the request contained therein, simply because the writer has been careless.

"We have before us an envelope with an indistinct post mark; the last part of the city name shows up as '——onifer,' the date as June 11, and the State does not show at all. In this envelope we received a coupon that was not filled out at all.

"In another envelope we received a coupon with the name 'S. K. Pickett, 987 Sledge Ave.,' filled in, but it did not give us the name of the city or state. Ordinarily, we would have secured it from the envelope, but in this case it was not noticed until the next day, and then our waste basket had been cleaned.

"These are only two instances of many cases of a similar nature which could be avoided if your readers would be more careful when writing for literature, etc.

"It has a tendency toward making the people who send in these coupons in this way feel 'sore' because they expect the literature, and we have no way of sending it because we don't know where to send it.

"If there is anything that you can do to make your subscribers realize that sometimes this is the reason why they don't receive literature and advertising souvenirs which they request, we shall be glad to have you do so, for it certainly will be a convenience to us and will eliminate any hard feeling on the part of our various friends who may say that we are neglecting them."

Yours very truly,

COLUMBIAN ROPE CO.,
Advertising Department,
Per E. P. Kohl.

We once knew a man who would not send out any letter until after he had read it over, checking the address, date and signature. Wonder if that wouldn't be a plan for more of us to adopt.